Dissertation on

STUDY OF BONE DENSITY IN MENOPAUSAL AND PERIMENOPAUSAL WOMEN

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BONAFIDE CERTIFICATE

This is to certify that **STUDY OF BONE DENSITY IN MENOPAUSAL AND PERIMENOPAUSAL WOMEN** is the record work done by Dr. P. ARUNMOZHI during her post-graduate course M.D (2003 - 2006) in the Department of OBSTETRICS AND GYNAECOLOGY, KILPAUK MEDICAL COLLEGE, CHENNAI in partial fulfillment of the requirements for the award of the degree M.D in OBSTETRICS AND GYNAECOLOGY as per the regulations laid down by THE TAMIL NADU Dr. M.G.R MEDICAL UNIVERSITY, CHENNAI..

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CONTENTS

INTRODUCTION

Improved healthcare services and socio economic growth has lead to increase in the life expectancy at birth and the number of elderly persons in our country. This has posed a new challenge to the health needs and care of elderly men and women.

The menopause is that point in time when permanent cessation of menstruation occurs following the loss of ovarian activity. The years prior to menopause that encompass the change from normal ovulatory cycles to cessation of menses are known as the perimenopausal transitional years, which is marked by irregularity of menstrual cycles.

Epidemiological studies have shown that during this phase women are at increased risk for arterial diseases, prone to urogenital problems and osteoporosis. Of these, osteoporosis is the most common consequence of menopause and currently is considered a major public health concern. Osteoporosis and its associated risk of fractures are preventable if diagnosed in time. Half of all the post menopausal women will have an osteoporosis related fracture during their lives including one quarter who will develop a

vertebral deformity and 15% who will suffer a hip fracture. As early as 1975 it was acknowledged that bone density measurements were related to future fracture risk. In the 1990's, the magnitude of this risk in relation to the age and bone density was carefully measured in several well designed longitudnal studies.

Several techniques exists for measuring bone mass or density. Quantitative Ultrasound (QUS) is a newer evolving promising technique which is finding increasing application. Retrospective and prospective studies have shown that QUS may be an alternative or complementary investigation to Dual Energy X-Ray Absorptiometry (DXA). QUS has been used in this study as a screening tool as it is inexpensive relatively portable and free of ionizing radiation

AIM OF THE STUDY

1 To assess the level of osteoporosis in perimenopausal and menopausal women

2 To screen the post-menopausal women having either natural or surgical menopause who are at high risk to have fractures.

3 To analyze the role of risk factor in identifying high risk women

REVIEW OF LITRATURE

Osteoporosis has been defined as "A Systemic skeletal disease characterized by low bone mass and micro architectural deterioration of bone tissue, leading to enhanced bone fragility and a consequent increase in fracture risk"

It is characterized by generalized reduction in bone mass due to subnormal osteoid production, excessive rate of de-ossification and sub normal osteoid mineralization. It has also been defined as bone mineral density that is below the age adjusted reference range, or more than one standard deviation below the mean for a particular age.

On the basis of the modified classification by NORDIN (1964) which takes account of findings by the World Health Organization (WHO) on causes of generalized and secondary osteoporosis, osteoporosis can be generalized or localized.

GENERALISED OSTEOPOROSIS

PRIMARY: On the basis of patterns of bone loss and fracture RIGGS and MELTON (1988) identified two types of primary osteoporosis. Type I primary osteoporosis is post-menopausal or osteoclast mediated and type II primary osteoporosis is senile or osteoblast mediated.

Type I primary osteoporosis is charecterised by rapid bone loss seen in recent post-menopausal women. The turnover of trabacular bone is accelerated. Therefore, distal radial and vertebral fractures are common.

Type II osteoporosis is characterized by age related bone loss, calcium deficiency or hyperparathyroidism. Primary generalized osteoporosis is the subject of this study.

EPIDEMIOLOGY

Osteoporosis is a global problem occurring in every geographic area and affecting 150 million men and women worldwide. Our knowledge of magnitude of the problem is very limited and most of the available data is from industrialized nations. In the USA, 10 million individuals have osteoporosis and 18 million have osteopenia. Osteoporosis affects 30% of post menopausal White women in the USA and the proportion rises to 70% in women over the age of 80 years. Globally osteoporosis is highest in Whites and Asians and lowest among Blacks.

According to the World Bank report, the world wide population of post menopausal women which was 470 million in 1990 is expected to increase to 1.2 billion by the year 2030 and 76% of these women would be living in developing countries. In India it is projected that by the year 2030 the population of the post menopausal women will be the second highest in the world, second to that in China. The WHO Technical Report Series 843-Assesment of Fracture Risk and its Application to screening for post menopausal osteoporosis, predicts a significant increase in fracture neck of femur among the Asian population over a period of time. The incidence of fracture of the hip is likely to rise across the world from 840,000 in 1986 to approximately 6.26 million in 2050 and 71% of these fracture are likely to occur in the developing world. Indian women are likely

to have a fracture incidence of neck of femur, of approximately 1.2 million per year. Thus the burden, of osteoporosis in the Indian scenario will be immense

THE INDIAN SCENARIO

Osteoporosis is highly prevalent in India. An estimated 61 million people in India are reported to be affected by it. Recent data indicate that Indians have lower bone density than their North American and European counterparts. It is reported that osteoporotic fractures occur 10 to 20 years early in Indians as compared to Caucasians and that bone mineral density (BMD) in Indian population were approximately 15% lower than those in Caucasian women.

THE BURDEN OF OSTEOPOROSIS

ECONOMIC: The National Osteoporosis Foundation in the USA estimates the cost related hospitalization, out patient care, long term care, and disability due to osteoporotic morbidity to be more than 60 billion dollars annually. In 1995, osteoporotic fractures were the cause of 432,000 hospital admissions in the US. Heath care expenditure attributable to osteoporotic fracture in the USA in the year 1995 was estimated to be US dollars 13.8 billion. The total number of deaths related to hip fracture disease ranges from 20,000 to 30,000 annually.

SOCIAL: Fracture related to osteoporosis are common. Every second woman and every third man over the age of 50 will eventually suffer from an osteoporosis related fracture. The lifetime risk for an osteoporotic fracture of hip, spine or wrist has been reported to be 40%. The risk for hip fracture is between 11 and 18 percent in women, which is equal to the combined risk for breast cancer and ovarian cancer, and exceeds her risk of developing endometrial or breast cancer.

PATHOPHYSIOLOGY

The basic unit of bone is the Haversian system which is also known as Osteon, the center of which is filled with osteoblasts and osteoclasts. Osteoblasts are the prime cells responsible for major production and synthesis of protein and mineralisation of bone. Osteoclasts are primarily responsible for bone resorption.

There are three aspects of physiology that comes into prominence when osteoporosis is discussed

- Re-Modeling
- Influence of Hormones on Bone
- Influence of Nutrition on Bone

Bone remodeling is regulated by systemic hormones and by growth factor which include Transforming Growth Factor alpha and beta, insulin like growth factor, platelet derived growth factor, interleukins, cytokines and prostaglandins

RE-MODELING: Modeling and re-modeling change the structure and shape of the bone continuously. Modeling takes places during fetal life and goes on till the second decade. Bone is formed in location in such a way as to change the shape and micro architecture of the skeleton

Bone re-modeling occurs throughout adult life. This includes bone formation and resorption and since it occurs at the same anatomical location, there is no significant structural change in the shape of the bone. The bio mechanical integrity and strength of the skeleton is as a result of re-modeling. Approximately 5 to 10 % of bone is replaced every year by re-modeling. The morphological dynamic structure of turnover is the BASIC MULTICELLUAR UNIT (BMU).

The re-modeling process is initiated by osteoclastic activity and is controlled by various hormones and locally produced cytokines.

INFLUENCE OF HORMONES ON BONE: A number of hormones play a significant role in bone metabolism and include estrogens, progesterone, growth hormone, testosterone, cortisone, thyroid hormone, calcitonin and insulin.

Estrogens play an important role in maintenance of bone strength. When estrogen levels are declined bone remodeling increase. Each remodeling unit is initiated by osteoclastic excavation followed by osteoblastic refilling. Estrogen exerts tonic suppression of remodeling and maintains a balance between osteoclastic and osteoblastic activity. In the absence of estrogen, osteoclastic activity predominates resulting in bone resorption.

The precise mechanism of action for sex steroid protection of bones remains unknown. However, a growing body of knowledge indicates complex interactions at the molecular level with both a classical pathway involving genomic transcription by hormone receptors and a non-genomic pathway that inhibits apoptosis. Increased efficiency of calcium absorption secondary to estrogen induced enhancement of the availability of vitamin D and a direct role for the estrogen receptors in the osteoblasts are important factors.

Many estrogen dependent growth factors and cytokines are involved in bone re-modeling. Estrogen modulates the production of bone resorbing cytokines such as interleukin 1 & 6, bone stimulating factors such as insulin like growth factors 1 & 2, colony stimulating factor, osteoprotegerin and transforming growth factor beta. Estrogen increases vitamin D receptors in osteoblasts and this may be a method by which estrogen modulates vitamin D activity in bone. There is little evidence that estrogen affects bone by altering the circulating calcitropic hormones. Thus the actions of estrogens are primarily direct effects on bone and important effects on vitamin D metabolism, and renal and intestinal handling of calcium.

The importance of loss of ovarian function in the evaluation of post menopausal osteoporosis was first emphasized by Albright and Collaborators in 1940.

INFLUENCE OF NUTRITION ON BONE:

Vitamin D: Role of vitamin D is increasingly being regarded as that of a calcitropic hormone. This is considered as a major steroid hormone that plays a vital role in calcium metabolism.

Calcium: Calcium alters the bone related hormones and local hormones and alters physical chemical properties of the bone mineral. The major mechanism whereby calcium affects the bone is probably through inhibition of Parathyroid hormone secretion.

Calories: Osteoporotic patients frequently have low intake of all nutrients.

Vitamin K: Vitamin K prevents carboxylation of GLA proteins, including osteocalcin.

Vitamin A: Vitamin A has been shown to increase bone resorption, and high levels are associated with osteoporosis. Excess in dietary intake of vitamin A is associated with reduced bone mineral density and increased risk of hip fracture.

RATE OF BONE LOSS

Evidence has shown that the bone mass peaks in the second decade of life, although heredity and environmental factors may influence this timing. Peak bone mass is

approximately 20% greater in men than women and is greater in black than whites. Gradual lose of skeletal mass begins to occur in the fifth or sixth decade of life in man and in both the decade in women. After the age of about 50 years, bone is lost at a rate of 0.75% to 1% per year which increases to a rate of 2% to 3% after menopause.

CLINICAL MANIFESTATION OF OSTEOPOROSIS

These include acute or chronic back pain, loss of height with change in body stature, fracture after minimal trauma, restricted movement, immobility, dependence on nursing, loneliness, depression, reduced quality of life and increased mortality.

DENSITOMETRY

The term ‘peak bone mass’ is defined as the amount of bone that is present at the end of skeletal maturation and determines in a major way, the onset of osteoporosis in later life. This peak bone mass occurs between 30 and 35 years of life, both in the male and female, but there is rapid decline in the bone mass in the post-menopausal female. A fracture risk is present particularly in osteoporosis since the bone mass that is present in any point of life during adult life is the variation between the amount accumulated at the

time of peak bone mass and the loss with ageing. Hence, the increase in bone mass is an important factor to prevent osteoporosis at a later date.

BONE MINERAL DENSITY

Bone mass is directly dependent both on volume/size and the density of the mineralized tissue and contained within the periosteal envelope. Bone Mineral Density (BMD) is a summation of several structural components which may evolve differently in response to genetic and environmental factors but bone mineral density is directly proportional to bone strength and would indicate the extent to which a fracture can occur at various sites in the human body

Bone mineral density measurement has a significant relation to fracture risk, The first prospective study to evaluate the association between bone density and fractures were published in 1975. Ross Et Al in a four year study of bone mass at the calcaneus showed an odds ratio of 5.0 for fracture of the spine.

Cummings Et Al in a study of 8134 post menopausal women showed odds ratio of 2.0 for the fracture of the hip using bone mass of the calcaneus.

The odds ratio for the fracture of the wrist was 1.8 in a study by Black et al.

DIAGNOSING OSTEOPOROSIS

The relation between bone mineral density and fracture risk in untreated patients has been evaluated prospectively in several studies. A decrease in BMD is associated with increased risk of fracture. The predictive power of BMD for hip fracture is similar to the predictive power of blood pressure for stroke and better than the predictive power of serum cholesterol level for cardio-vascular disease. In post menopausal women the risk for hip fracture increases by a factor of 2.6 per each age adjusted standard deviation decline in BMD of femoral neck. The BMD at other sites (radius, calcaneus, hip and spine) has also been shown to co-relate with fracture risk at all sites.

Defining the risk for osteporotic fractures in only the first step in the final diagnosis of osteoporosis. Changes in BMD are observed with aging, in addition to differences in BMD between the sexes and ethnic groups. BMD results must be compared with those of age, sex, and race-matched controls. The use of T and Z score has become an important part of the interpretation of BMD measurements. The Z score gives the patient's result as the deviation from the mean of age-matched controls divided by the

standard deviation of this mean and is an indication of biologic variability. The T score is associated with the peak bone mass of young normal adults and calculated similarly to the Z score. The WHO has advocated the use of diagnostic thresholds based on a comparison with young normal person for the diagnosis of osteoporosis.

Table : WHO Criteria for Defining Osteoporosis

Condition	Description
Normal	BMD value with 1 SD of the young adult reference mean ($T \geq -1.0$)
Osteopenia	BMD value of more than 1 SD below the young adult mean but less than 2.5 SD below this value ($-1.0 > T > -2.5$)
Osteoporosis	BMD value of 2.5 SD or more below the adult mean value ($T \leq -2.5$)
Established Osteoporosis	BMD value of 2.5 SD or more below the adult mean value ($T \leq -2.5$) in the presence of one or more fragility fractures

INDICATIONS FOR BONE MINERAL DENSITY MEASUREMENT

Deciding which patients to consider for BMD measurements usually involves weighing various risk factors on individual basis.

RISK FACTORS

The risk factors for osteoporosis are enumerated below

A. Natural Progression
    1. Increasing age
    2. Female
B. Constitutional
    1. White (fair-skinned) or Asian origin
        a. Black and Hispanic patients have lower rates
    2. **Family History** Maternal **Hip Fracture**
    3. Low body weight or small stature
        a. Weight below 58 kilograms
        b. **Body Mass Index** (BMI) <25
C. **Family History**
    1. **Osteoporosis**
    2. Kyphosis
    3. Pathologic fracture
D. Lack of Bone loading or **Exercise**
    1. Sedentary
E. Early **Hypogonadism**

1. **Premature Ovarian Failure** (e.g. **Female Athlete Triad**)
2. Orchiectomy for **Prostate Cancer** in men

F. Inadequate Calcium Intake or absorption

1. Low calcium intake
2. Smoking (female RR 2.0, male RR 5.0)
3. Excessive alcohol
4. High Caffeine intake

G. No longer considered a risk factor

1. High phosphate (soda) does not cause **Osteoporosis**

National Institute of Health recommends using the individualized approach in deciding which patients should have BMD testing. The National Osteoporosis Foundation has recommended specific guidelines for selective screening.

BONE MASS ASSESSMENT

Bone densitometry is the single best predictor of osteoporotic fracture risk.

Both peripheral and central bone sites can be measured to assess BMD. Because osteoporosis is a systemic disease, the risk of spine or hip fracture can be estimated from measurements obtained at peripheral measurement sites. However, bone mass may be discordant at various skeletal site within an individual patient. Thus the skeletal area of most interest for fracture risk is a most accurate measurement site.

TECHNIQUES FOR MEASURING THE BONE MASS OR DENSITY

IONIZING

CONVENTIONAL SKELETAL RADIOGRAPHY: Conventional X-ray is relatively insensitive and bone lass is apparent only when bone mass has decreased by about 30 to 50 %.

RADIOGRAPHIC PHOTO DENSITOMETRY: The technique depends on measuring the optical density of X-Ray films of the bones. The radiation dose is the same as for radiogrammetry

RADIOGRAMMETRY: It relies on linear measurements in X-Ray films on cortical bone taken under standarised conditions. It is less sensitive and specific than absorptiometric measurements.

SINGLE ENERGY X-RAY ABSORPTIOMETRY: It most commonly uses a gamma-ray source coupled with a scintillation detector, which together scan across the area of interest.

The technique has been used in the peripheral skeletal. The radiation dose is < 1 μSv

DUAL ENERGY ABSORPTIOMETRY: It is based on the method of X-ray spectro-photometry. The principle behind DEXA is that different tissues attenuate radiation of distinct energies to different extents. Measurements can be made at both peripheral and central skeletal. DEXA has high short term and long term precision.

Table: Different bone densitometry techniques

Technique	Regions of interest	Units reported	Precision (%CV)	Radiation exposure (μSv)
DXA	Spine, hip, total	BMD (g/cm2)	1%-2%	1-10

	body			
pDXA	Radius, calcaneus	BMD (g/cm2)	1%-2%	0.1
QCT	Spine	BMD (g/cm3)	3%	50-500
pQCT	Radius, Tibia	BMD (g/cm3)	1%-2%	1-3
RA	Phalanx	BMD (g/cm2)	1%-2%	10
QUS	Calcaneus, tibia, multisite	BUA (dB/MHz) SOS (m/s)	0.1% - 5%	None
MRI	Peripheral, multisite	app. BV/TV (%) app. Tb.Th (mm) app. Tb.N (mm-1) app. Tb.Sp (mm)	2%-9%	None

QUANTITATIVE COMPUTED TOMOGRAPHY (QCT): In QCT a thin transverse slice through the body is imaged which gives a measure of volumetric bone mineral density. Cancellous bone can be measured independently of surrounding cortical bone. The advantage of the technique is that the cancellous bone can be examined separately from cortical bone.

NEUTRON ACTIVATION ANALYSIS (NAA): The application of NAA to bone mineral measurement relies on the fact that 99% of the calcium in the body is in the

skeleton. When the area under examination is irradiated with neutrons many of its constituent elements become radio-active and can be identified and quantified by examining the characteristic gamma-ray emission.

QUANTITATIVE ULTRASOUND

It is due to the increasing awareness of the impact of osteoporosis causing morbidity and mortality, due to its complications to the patient and in addition to the financial burden on the patient or the public health system that there is growing interest in the technique for early diagnosis of the disease process. Although DEXA which provide

BMD is an accepted standard it explains only about 70% – 75% change in the strength of the bone. It does not take into account the remodeling of bone, ineffective bone architecture or the quality of the bone, bone micro-architectural distortion due to fatigue or stress and measurement artifacts due to overlying high density substance.

QUS is a newer evolving promising technique which is finding increasing application. Calcaneum is the most common logical anatomical site for assessing bone mass by QUS. The other sites are proximal phalanges metacarpals radius, etc.

TECHNIQUE

The conventional ultrasound works on pulse-echo technique. They produce a reflective image. The QUS system produces a transmission image with the help of two transducers used for the purpose of bone characterization range for 0.1 to 1 MHz. The parameters which are conventionally assessed are Broadband Ultrasound Attenuation (BUA) and Speed of Sound (SOS). The BUA values are directly affected by the bone mass of the assessed calcaneum whereas SOS represents the internal architecture of the trabaculae and or the elasticity of the bone.

The stiffness Index relates to bone density, structure and elasticity of the bone and provides a clinically significant score with a high diagnostic sensitivity. The stiffness index for a patient is direct indicator of the fracture risk of the patient.

The scientific evidence permits conclusions comparing the ability of US (which measures the "Stiffness index" of bone) to DXA (which measures bone density) to predict fracture risk. The evidence consists of 3 prospective cohort studies, and a number of cross-sectional and/or retrospective studies. The two studies that are strongest methodologically each followed several thousand patients prospectively over a 2-year period and directly compared the predictive ability of US of the heel with DXA. Both studies were consistent in reporting that US of the heel was roughly equivalent to DXA in predicting overall fracture risk. DXA of the hip was somewhat more predictive for hip fractures than US of the heel, but the confidence intervals for these relative risks overlapped widely.

Table : Sensitivity and specificity at various T score cut-offs

T Score	DEXA femoral neck		Heel stiffness Index	
	Sensitivity	Specificity	Sensitivity	Specificity
-3.5	25	97	71	66

-2.5	62	80	98	28
-2	79	68	99	20
-1	99	25	100	7
Optimal cut-off	-2.2		-3.4	
	76	74	75	63

The calcaneus is the most popular measurement site for several reasons: Calcaneus consists of almost only metabolically active trabecular bone and may early express skeletal changes, is weight-bearing bone like the neck of femur and the vertebral bodies and is easily accessible.

Ultrasound is a traveling mechanical vibration and the mechanical properties of the medium progressively alter the shape, intensity (energy per second per unit area) and speed of the propagation wave. Therefore, the nature of the method being able to provide some qualitative bone features in addition to bone quantity seems to be especially promising.

QUALITY OF BONE ASSESSED BY QUS

A potential of QUS to express qualitative features of bone seems to be one of the most important advantages of the method.

Bone disease may affect both bone quality and quantity. It is well known that BMD is important but no sole determinant of bio-chemical property of skeleton. Fundamental rules of bio-mechanics indicate that the strength depends not only on material quantity but also on its internal structure size and bio-chemical properties. It should be known that the risk of bone fracture depends on its density, internal structure (mainly trabacular, anisotropy, connectivity and porosity) and bio-mechanical properties.

In contrary to DEXA method QUS expresses anisotropic properties of bone and internal structure of trabaculae. Such data indicate that QUS may give some additional data to those given by densitometry evaluation of bone independent of the BMD.

QUS may provide some additional data on fracture risk because QUS parameters express both bone mass and bone quality. QUS measures two parameters: speed of sound (SOS) and broadband ultrasound attenuation (BUA). SOS is believed to express elasticity and bone mass and higher SOS values are obtained in denser and more elastic bone tissue. BUA is a function of absorption and dispersal of ultrasound wave, and is associated with density and structure of trabecular bone. Some researchers consider that common use of QUS and BMD measurements may better express biomechanical

competence of bone than BMD measurements alone, and others stated that QUS parameters are able to predict mechanical properties of bone independently of bone density. It could be concluded that a potential of QUS to express some qualitative features of bones cannot be neglected. This ability of the method is the most promising area of future studies and a combination of data on qualitative bone features and bone quantity would lead to wider clinical applications in the future.

TREATMENT OF OSTEOPOROSIS

HORMONE REPLACEMENT THERAPY: Estrogen preserves positive calcium balance by suppressing the bone remodeling rate. It decreases the activation of new remodeling units and thereby suppresses parathyroid hormone mediated bone resorption. The incidence of osteoporotic fractures is 2-3 times greater in women than men because the peak bone mass is lower and there is an accelerated loss after menopause (Melton et al 1992). Progestogens should be administered along with estrogen therapy for all women who have intact uterus. Continuous combined estrogen and progestogen avoids monthly withdrawal bleeding to a considerable extent.

The clinical effects of HRT on preservation of bone mineral density hasbeen proved beyond doubt. However, individualization of treatment, close monitoring and total health care is essential to exert a long term benefit. HRT can be started in the

perimenopausal period to treat climacteric and urogenital symptoms and continued for a long time for prevention of osteoporosis and cardiovascular disease. However, for effective prevention, 5 to 10 years is the period recommended.

Several clinical trials have demonstrated the reduction of fracture risk and it is shown that duration of therapy should be as long as possible because the bone mass starts falling again when HRT is stopped. The contraindication for estrogens are history of breast cancer or endometrial cancer, severe liver dysfunction and porphyria. In women with fibroids, endometriosis, migraine, venous thrombosis and familial hypertriglycerdaemia, gallstones, epilepsy and those with increased risk of breast cancer, the clinicians need to be cautious and consider alternative therapies or monitor them very closely.

Felson et al (1993) investigated the effects of 10 years of HRT on BMD in postmenopausal women. After 10 years of therapy, the bone mineral content was significantly higher in the HRT group when compared to those who received no treatment. They noted that women treated for 3 to 4 years had no significant improvement.

Schneider, et al (1997) studied the importance of timing of postmenopausal estrogen for optimal bone mineral density. Estrogen initiated in the early menopausal period and continued into late life is associated with the highest bone density.

Nevertheless estrogen begun after age of 60 years and continued appears to offer bone-conserving benefit.

Good nutrition, calcium supplementation, weight bearing exercises and minimising risk factors such as smoking, excessive alcohol and immobilization certainly help. In Mumbai, 70% of women in the upper socio-economic and education strata knew about HRT but among the lower middle class, only 2-5% of women knew about HRT.

ALTERNATIVE THERAPIES

Calcium supplements, bisphosophonates, calcitriol, calcitonin, anabolic steroid and sodium fluoride have been tried. Bisphosphonates such as Alendronate have been shown to attenuate bone turnover and specifically inhibit osteoclasts mediated bone resorption. The increase in BMD is maintained during the treatment and for 12 months after the treatment. Liberman et al (1995) reports optimal increase in BMD with 10 mg/day dose and an increase in bone mass of 8.8% at lumbar spine and 5.9% at femoral neck after 3 years of therapy. Addition of Alendronate to ongoing HRT resulted in 5 times greater increase in bone mineral density than HRT alone, in postmenopausal women with low BMD.

Calictriol deficiency is believed to be significant factor in postmenopausal osteoporosis and its presence is an important regulator of intestinal calcium absorption. Anabolic steroids can be used only for short periods in extreme cases of debility and osteoporosis. Calcium supplements are useful when used along with estrogens in sufficient doses – 1000 to 1500 mg. Vitamin D3 is needed for intestinal calcium absorption. With increased age, the kidney produces less 1,25-dihydroxy vitamin D 9th active form) from Vitamin D. Raloxifen is a selective estrogen receptor modulator (SERM) and has a favorable effect on bone and lipids and does not stimulate endometrium or breast. Alpha D3 is used to regulate mineral metabolism by increasing calcium and phosphate absorption from the intestinal tract as well as by mobilizing these minerals from the bones.

These alternatives therapies have to be specially considered for women who do not wish to take HRT or when HRT is contra-indicated.

MATERIALS AND METHODS

The present study has been conducted taking 98 perimenopausal and 112 postmenopausal women in age group from 40 and above between the period of Jan'04 to Aug '05.

The study was conducted at Kilpauk Medical College, Kilpauk , Chennai

STUDY DESIGN

Randomized prospective study

INCLUSION CRITERIA

Perimenopausal women age ≥ 40 yrs

Post menopausal women who had experienced surgical/natural menopause irrespective of age

EXCLUSION CRITERIA

1. Women with preexisting atraumatic fracture
2. Patients with secondary osteoporosis
3. Women with chronic illness
4. Women with current use of thyroid hormones or any other drug that might affect bone mass like diuretics, anticonvulsants, barbiturates.

The BMD was assessed using Lunar Achilles Utrasound Densitometer software version 1.3 in os calcis of right foot. The BMD was assessed as stiffness using SOS (speed of sound) and BUA values (Broad Band Ultrasound Attenuation).The ultrasound method uses the principle of sound attenuation to plot mineral density. It is non-invasive, less expensive and painless procedure.

The results of BMD were analysed when expressed in standard deviation units in comparison to the young normals and are known as "T-scores".

Calculation formula:

$$\text{T-score} = \frac{\text{Patients BMD} - \text{Reference BMD}}{\text{Reference SD}}$$

The % Young adult value (T-score) compares a patient's stiffness value with expected value for 20 years old subject of same sex and nationality. The risk of fracture doubles for each 1 SD decrease of bone mineral density.

The %age matched value (or Z-score) compares the patient's stiffness value with expected stiffness value for reference group of same age and sex. The bone mineral density declines along the normal regression line with advancing age. The bone mineral

density of the female is assessed when compared with young normal adults of same sex and nationality. i.e. T-score".

A detailed history specially related to menopausal problems and general medical problems was noted. High risk factors such as surgical menopause with oopherectomy, history of treatment with glucocorticoid etc. were noted.

Patients answered a questionnaire inquiring about their age, physical activity over the last 5 years, and knowledge of family history of osteoporosis. Physical activity was analyzed as "positive",
i.e., regularly practiced throughout the year (at least twice a week), or "negative", i.e., all other situations. The following activities were considered to be sports: walking, cycling, and swimming. A complete dietary inquiry was obtained, and the energy, caffeine and calcium intakes were calculated. Patients were weighed and height measured and BMI was reported as kg/m2.

For comparison, patients were grouped according to Z score and T score. Those with a Z score below -1 (group 1) were compared to those with a Z score equal to or greater than -1 (group 2). The effect of the different variables on the Z score was studied by stepwise multivariate regression analysis.

And those with the T score below -1 (Normal) were compared with the T score equal to or grater than -1 and less than -2.5 (Osteopenia) and T score equal to or grater than -2.5 (Osteoporosis)

Results were analysed using NCSS software.

OBSERVATION AND ANALYSIS

Table 1

AGE DISTRIBUTION

Age in Years	Normal	Osteopenia	Osteoporosis	Total
41-45	61	2	1	64
46-50	21	19	2	42
51-55	5	23	8	36
56-60	11	5	12	28
> 60	18	21	1	40

Total	116	70	24	210

Table 1 shows the age distribution of the study population. The age ranges from 41 years to 75 years.

Mean age for the study group was 52.72 yrs with the standard deviation of 9.59 years

50.6% of the study group were aged between 40-50, 30.4% patients were aged between 50-60 and 19% of the study group were aged more than 60.

46.6% of the study group were perimenopausal and 53.4% were post-menopausal.

11.42% of the study population had undergone Hysterectomy with removal of both ovaries

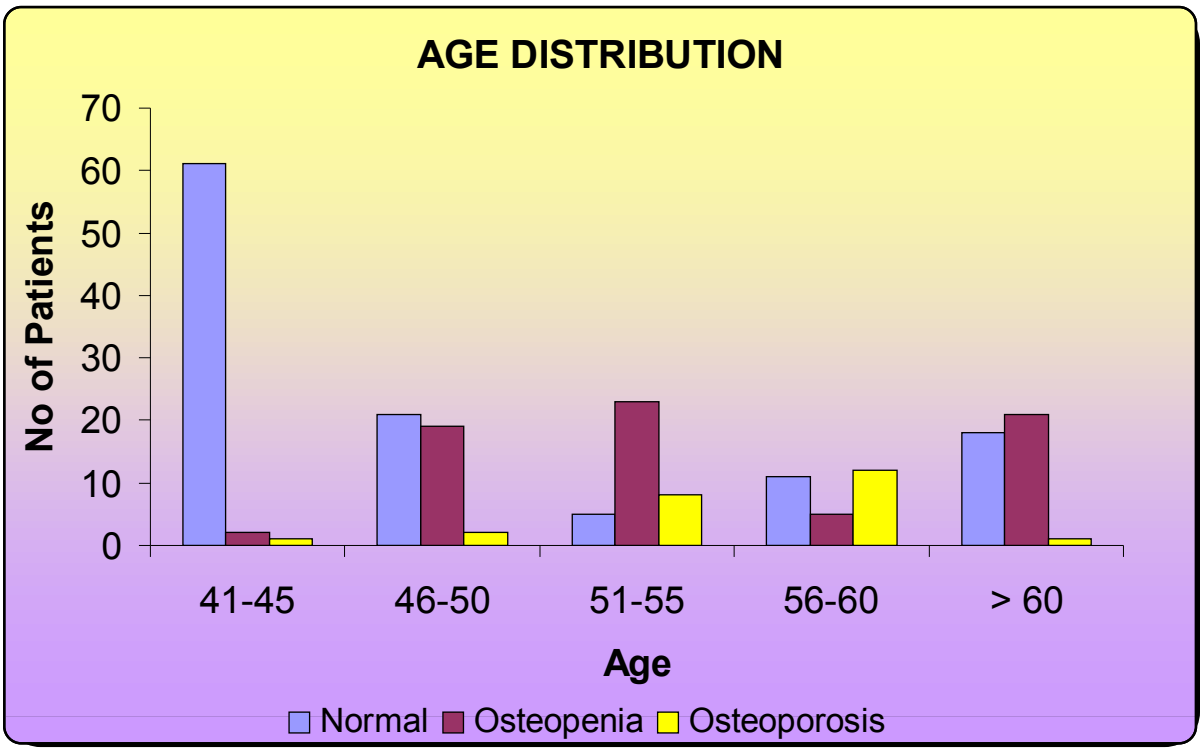

AGE DISTRIBUTION
No of Patients
70
60
50
40
30
20
10
0
41-45
46-50
51-55
56-60
> 60
Age
Normal
Osteopenia
Osteoporosis

Table 2

PERCENTAGE DISTRIBUTION OF BMD IN VARIOUS AGE GROUPS

Age	Normal T ≥ -1.0	Osteopenia -1.0 > T Score > -2.5	Osteoporosis T ≤ -2.5
41-45	95	3	2
46-50	50	45	5
51-55	14	64	22
56-60	39	18	43
> 60	45	52	3

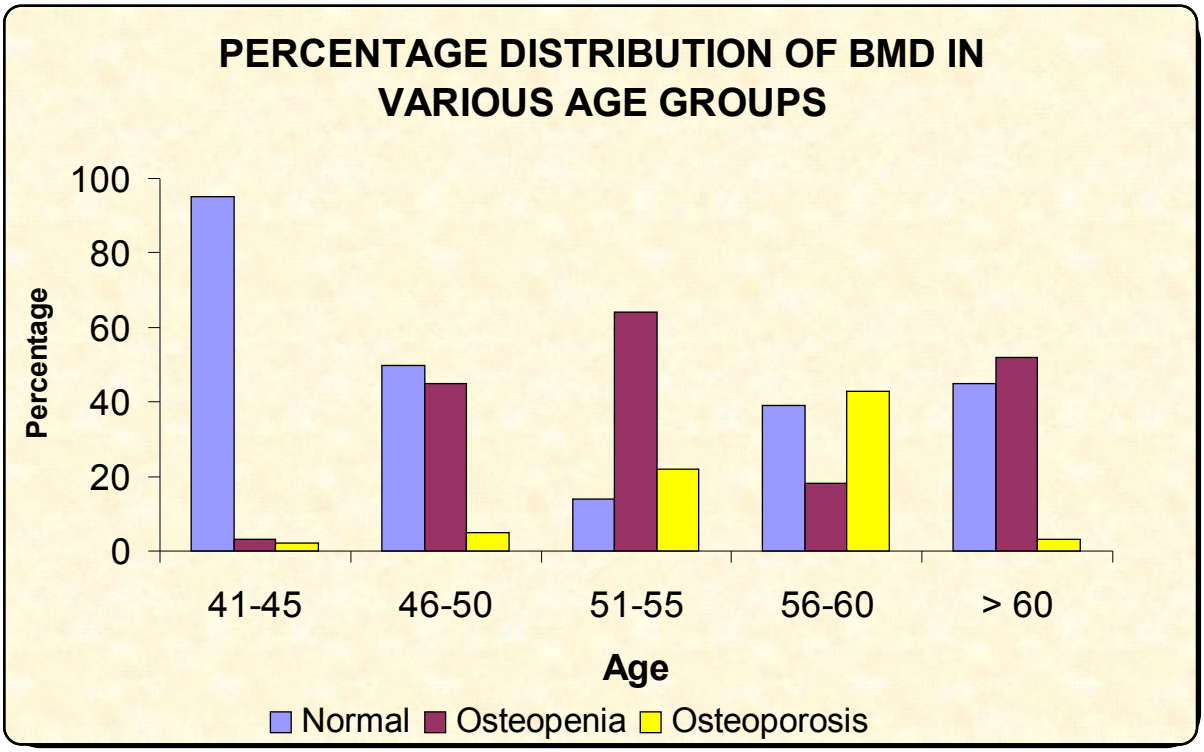

PERCENTAGE DISTRIBUTION OF BMD IN VARIOUS AGE GROUPS
100
80
60
40
20
0
Percentage
41-45
46-50
51-55
56-60
> 60
Age
Normal
Osteopenia
Osteoporosis

Table 3

DEMOGRAPHY

Place of Living	Perimenopausal	Menopausal	Total
Urban	80	90	170
Rural	18	22	40
Total	98	112	210

81% of the study population were from the urban area and the 19% from the rural area.

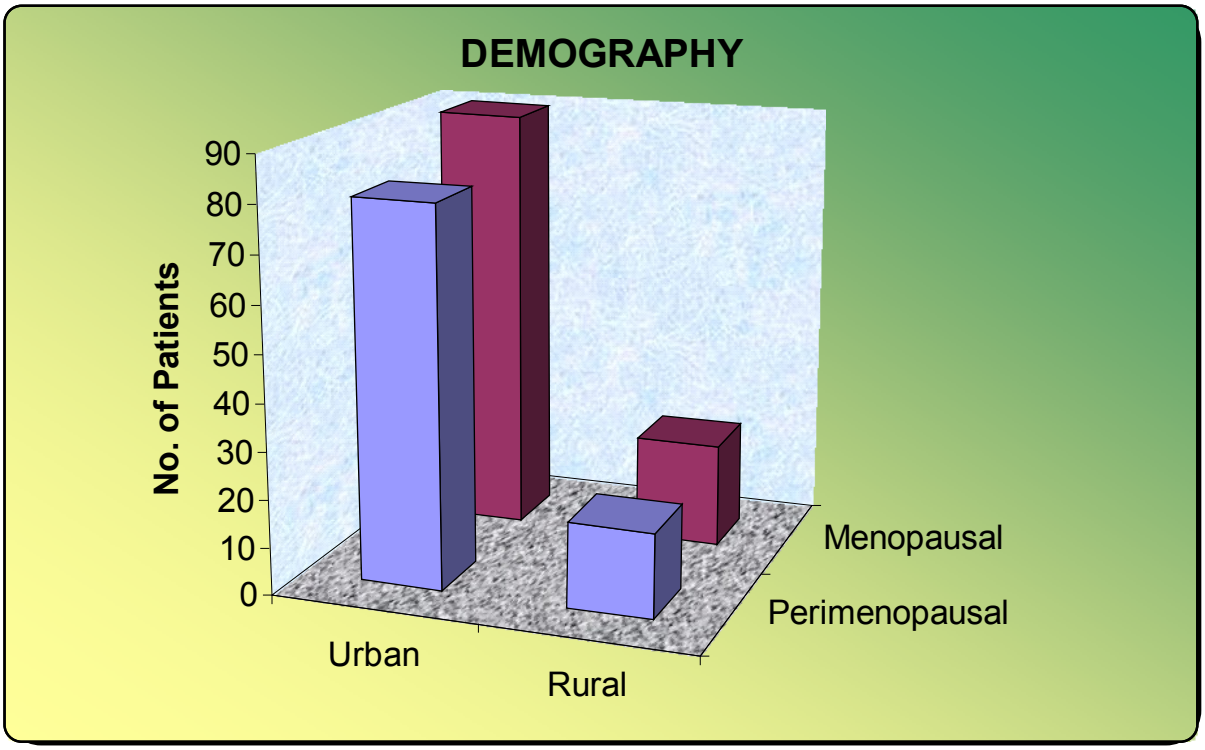

DEMOGRAPHY
No. of Patients
90
80
70
60
50
40
30
20
10
0
Urban
Rural
Menopausal
Perimenopausal

Table 4

DISTRIBUTION IN URBAN/RURAL AREA

Place of Living	Normal	Osteopenia	Osteoporosis	Total
Urban	102	50	18	170
Rural	14	20	6	40
Total	116	70	24	210

29% of urban population were osteopenic and 10% were osteoporotic

50% of the rural population were osteopenic and 15% were osteoporotic

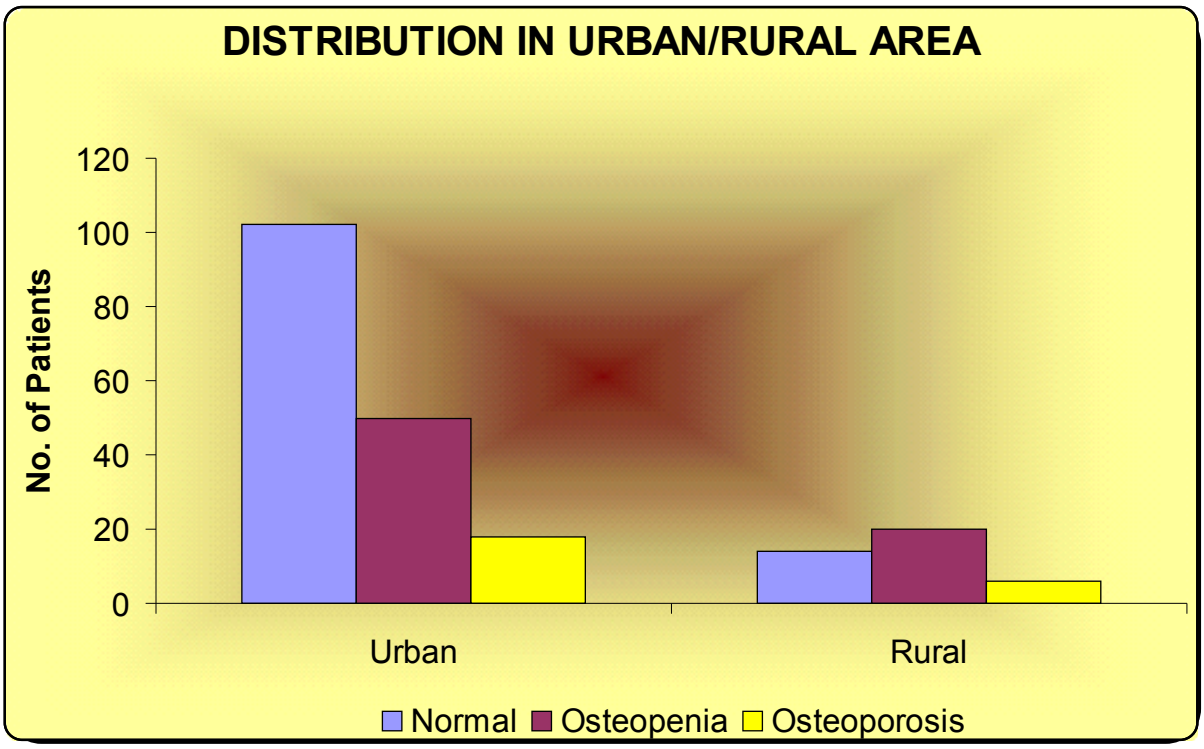

DISTRIBUTION IN URBAN/RURAL AREA
No. of Patients
120
100
80
60
40
20
0
Urban
Rural
Normal
Osteopenia
Osteoporosis

Table 5

EDUCATIONAL STATUS

Level of Education	Perimenopausal	Menopausal	Total
No Formal Education	50	62	112
Primary	43	38	81
Secondary	5	12	17
Total	98	112	210

53 % of the study population had no formal education, 39 % had primary education and 8 % had secondary education.

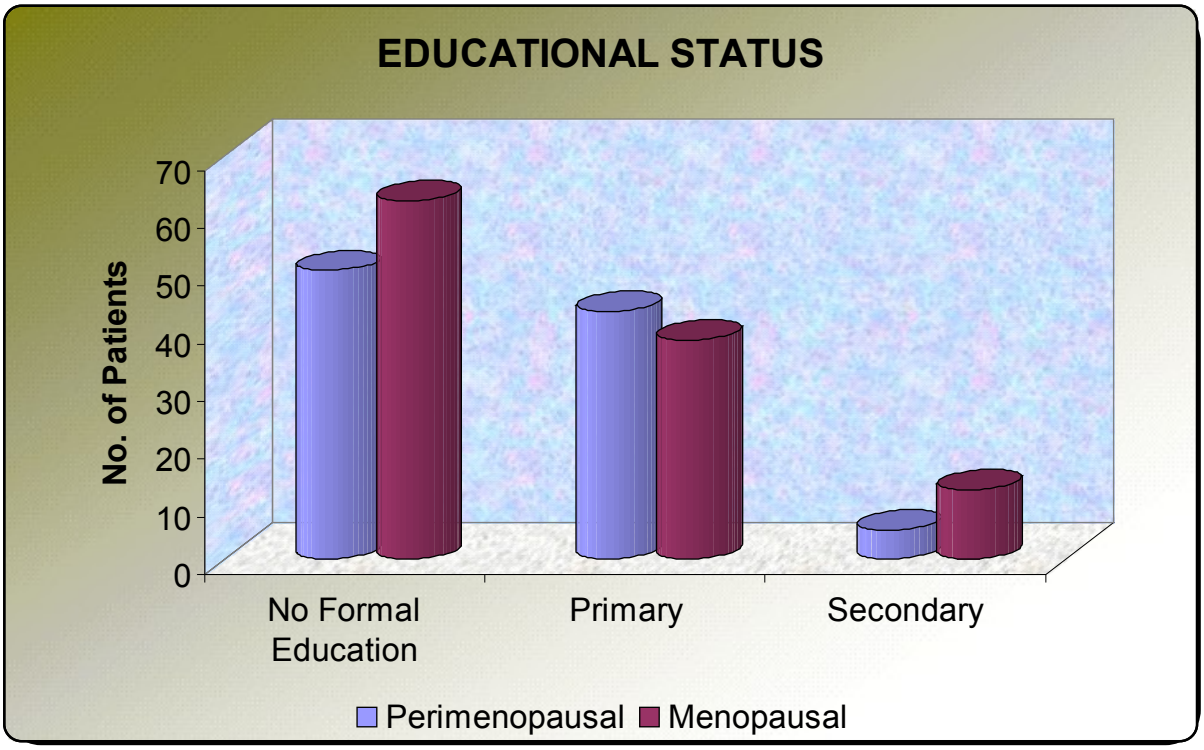

EDUCATIONAL STATUS
No. of Patients
70
60
50
40
30
20
10
0
No Formal Education
Primary
Secondary
Perimenopausal
Menopausal

Table 6

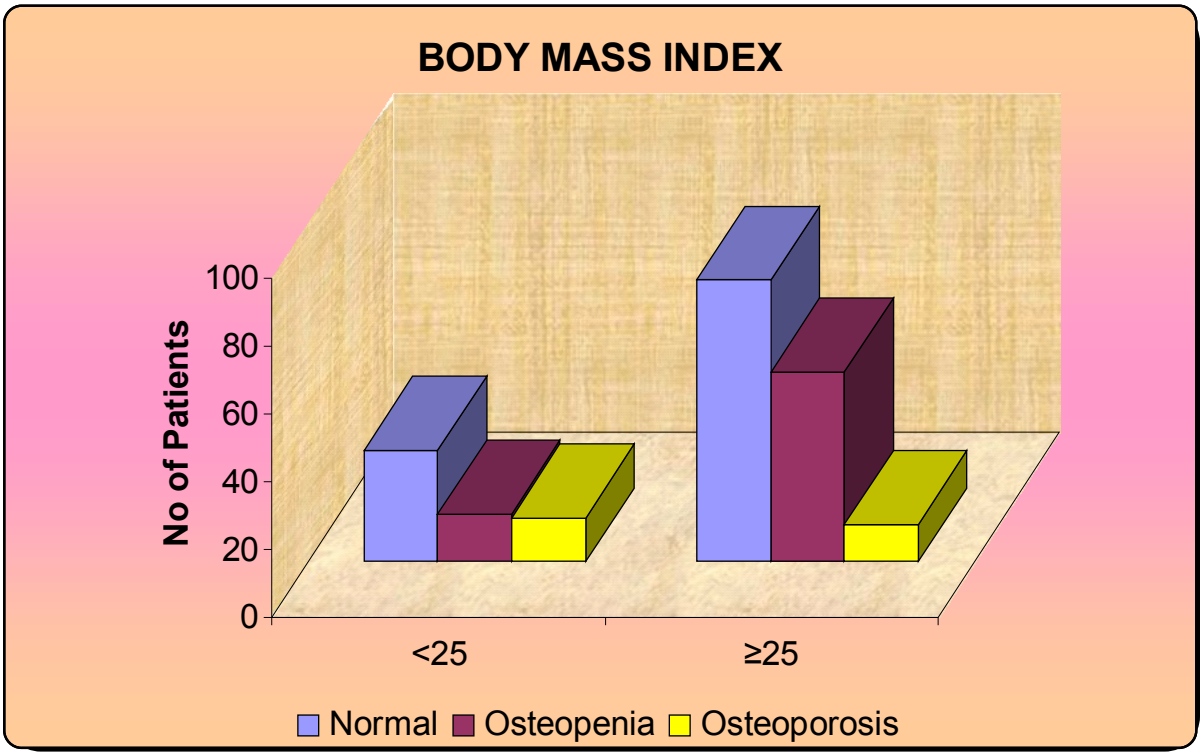
BODY MASS INDEX

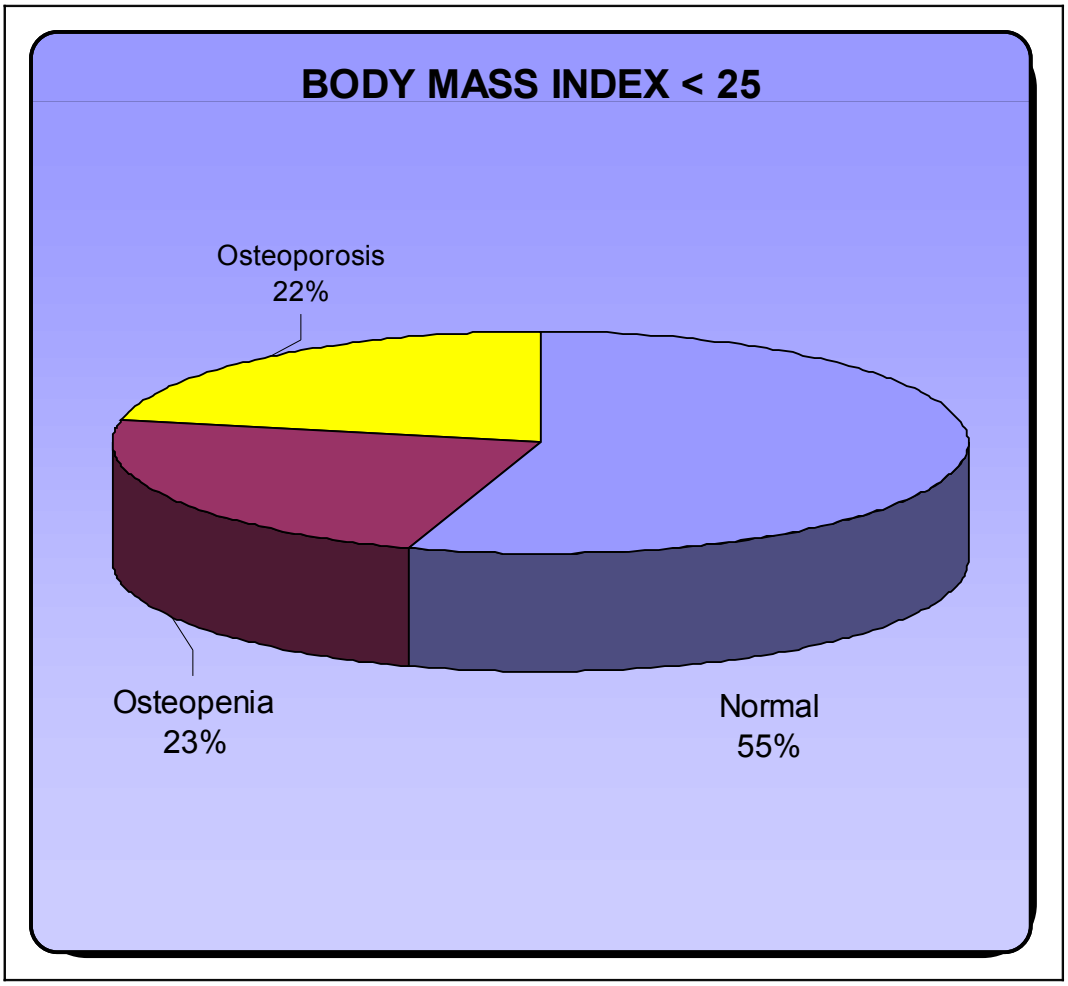
Body Mass Index	Normal	Osteopenia	Osteoporosis	Total
<25	33	14	13	60
≥25	83	56	11	150
Total	116	70	24	210

29% of the study group had BMI of less than 25 and 71% of the study group had BMI of ≥ 25

In the study population with the BMI <25, 23% had osteopenia and 22% osteoporosis.

In the study population with BMI ≥25, 37% had osteopenia, 7% had osteoporosis


BODY MASS INDEX
No of Patients
100
80
60
40
20
0
<25
≥25
Normal
Osteopenia
Osteoporosis


BODY MASS INDEX < 25
Osteoporosis
22%
Osteopenia
23%
Normal
55%

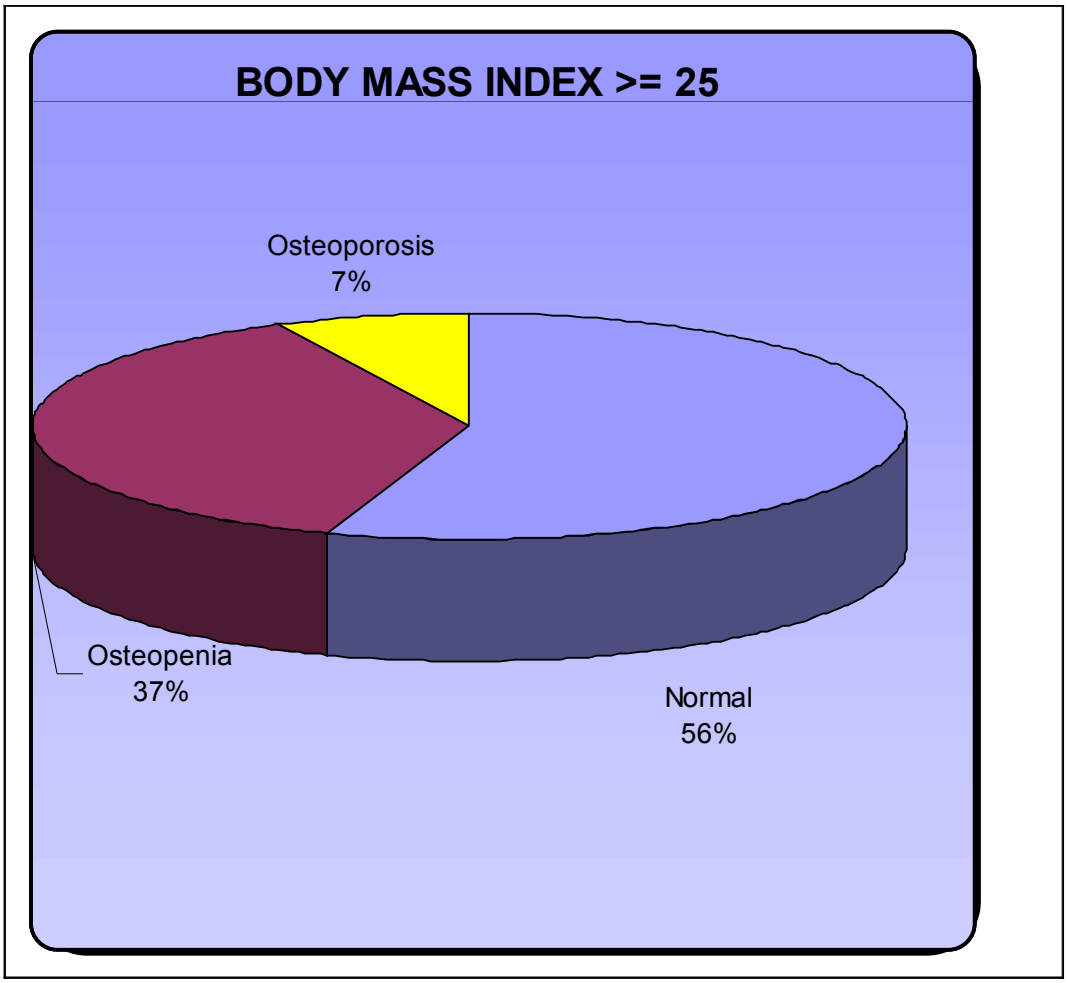

BODY MASS INDEX >= 25
Osteoporosis
7%
Osteopenia
37%
Normal
56%

Table 7

HISTORY OF MENOPAUSE

Menopause	Normal	Osteopenia	Osteoporosis	Total
NO	69	21	8	98
YES	47	49	16	112
Total	116	70	24	210

46.6% of the study group were perimenopausal and 53.4 % were post-menopausal.

In post-menopausal women 14.2% had osteoporosis and 43.75% had osteopenia

In the perimenopausal women, nearly 70% had a normal study and only 8% had osteoporosis

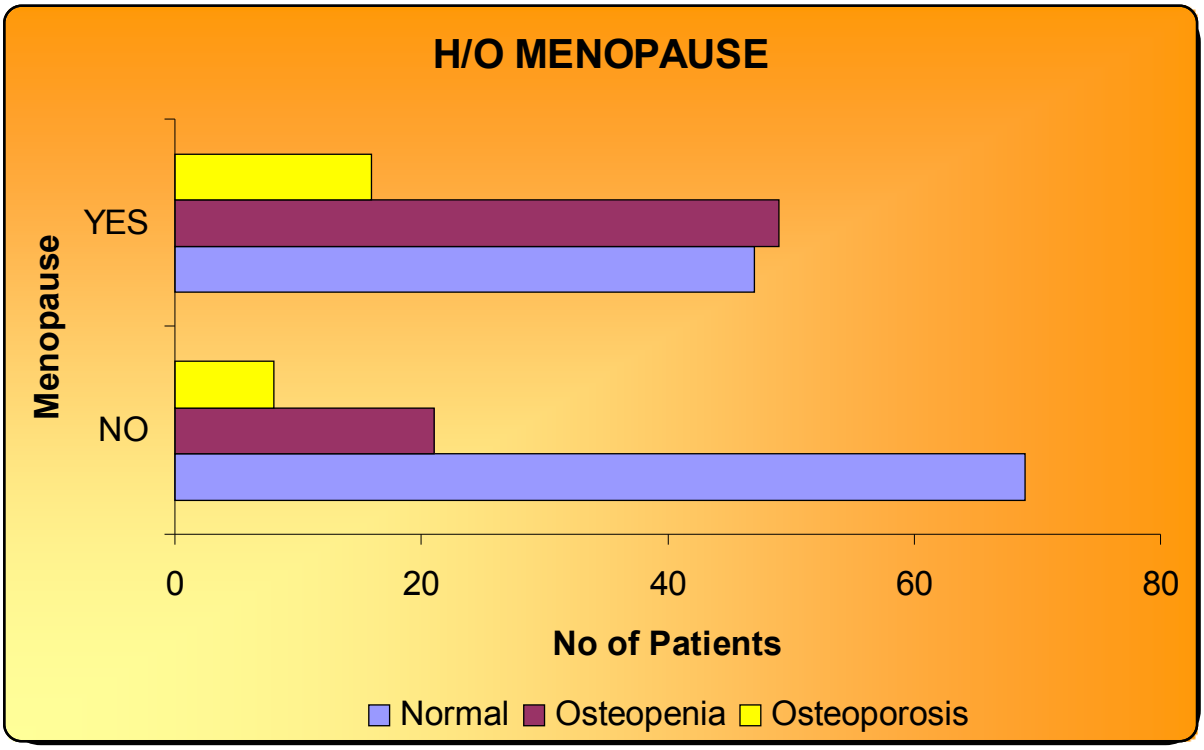

H/O MENOPAUSE
Menopause
YES
NO
0
20
40
60
80
No of Patients
Normal
Osteopenia
Osteoporosis

Table 8

SURGICAL MENOPAUSE

Surgical Menopause	Normal	Osteopenia	Osteoporosis	Total
Yes	6	13	5	24

24 women in the study group had undergone surgical menopause. The mean age of this group was 48.83 years.

The mean age of the study group with natural menopause was 59.76%

54% of the women who had undergone surgical menopause had osteopenia and 21% had osteoporosis.

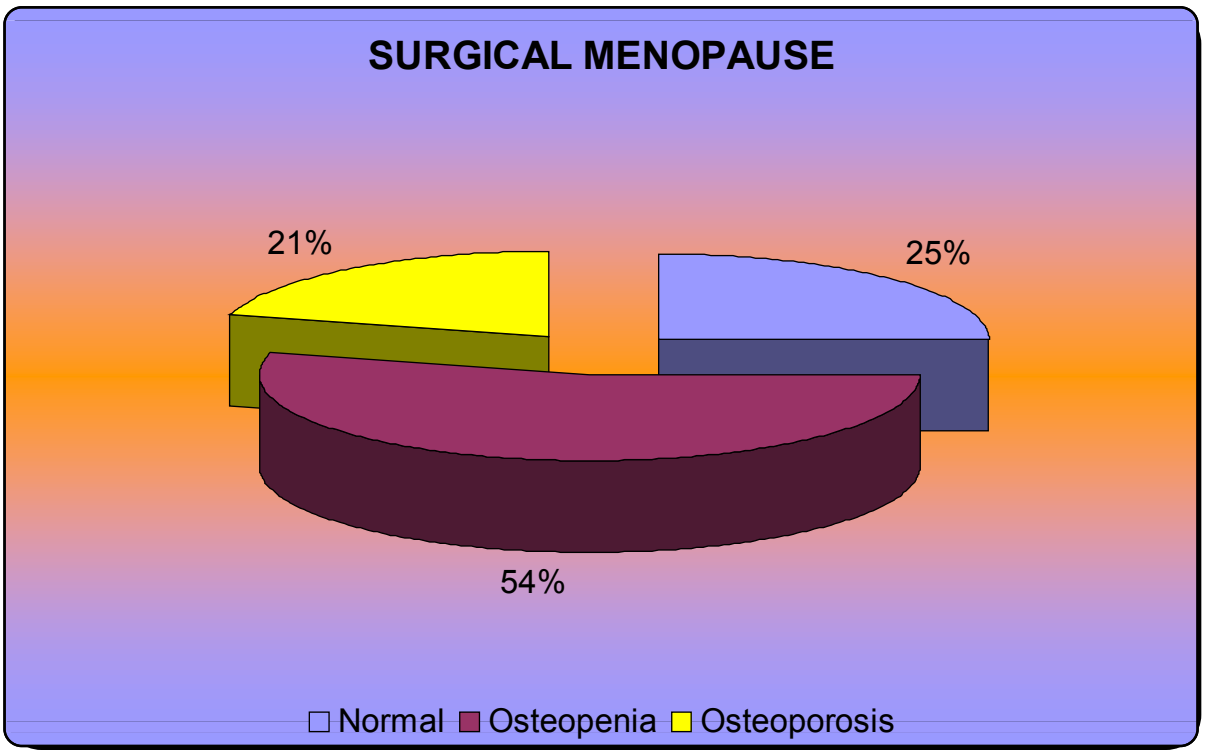

SURGICAL MENOPAUSE
21%
25%
54%
Normal
Osteopenia
Osteoporosis

Table 9

FAMILY HISTORY OF FRACTURE

Fracture	Normal	Osteopenia	Osteoporosis	Total
YES	7	13	16	36
NO	109	57	8	174
Total	116	70	24	210

In the study population, 18% had a family history of fracture of whom 44% has osteoporosis and 36% has osteopenia

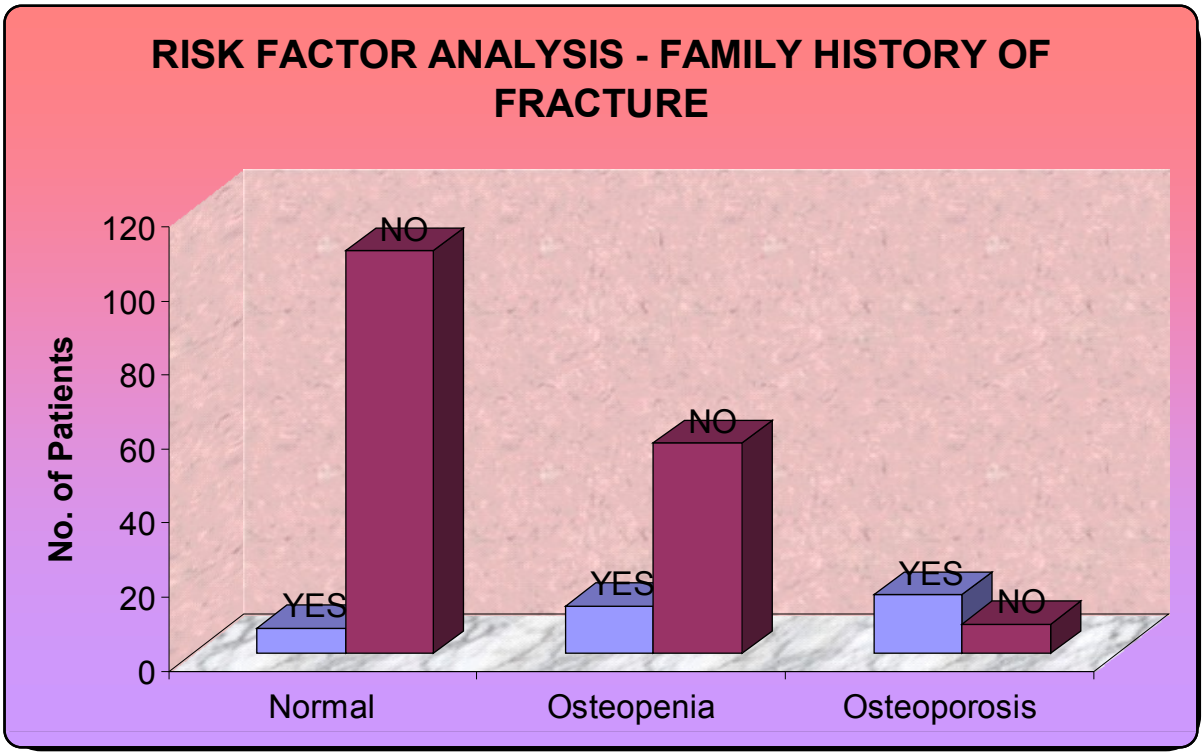

RISK FACTOR ANALYSIS - FAMILY HISTORY OF FRACTURE
No. of Patients
120
100
80
60
40
20
0
YES
NO
YES
NO
YES
NO
Normal
Osteopenia
Osteoporosis

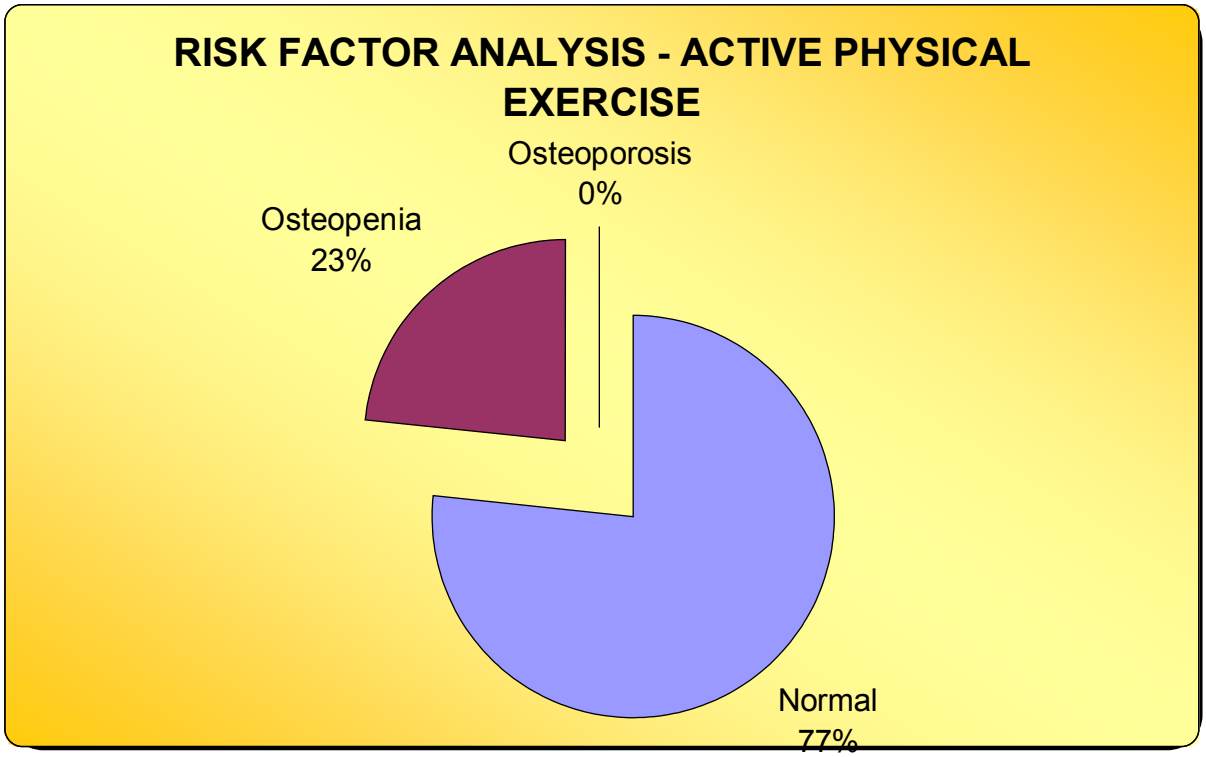
Table 10

PHYSICAL EXERCISE

Physical Exercise	Normal	Osteopenia	Osteoporosis	Total
Yes	49	15	0	64
NO	67	55	24	146
Total	116	70	24	210

69.5% of the study population did not have physical exercise and 30.5% had regular physical exercise. Of the study population who did not have regular physical exercise, 16% had osteoporosis and 38% had osteopenia.

Physical Exercise was associated with the lower incidence of osteoporosis


RISK FACTOR ANALYSIS - ACTIVE PHYSICAL EXERCISE
Osteoporosis
0%
Osteopenia
23%
Normal
77%

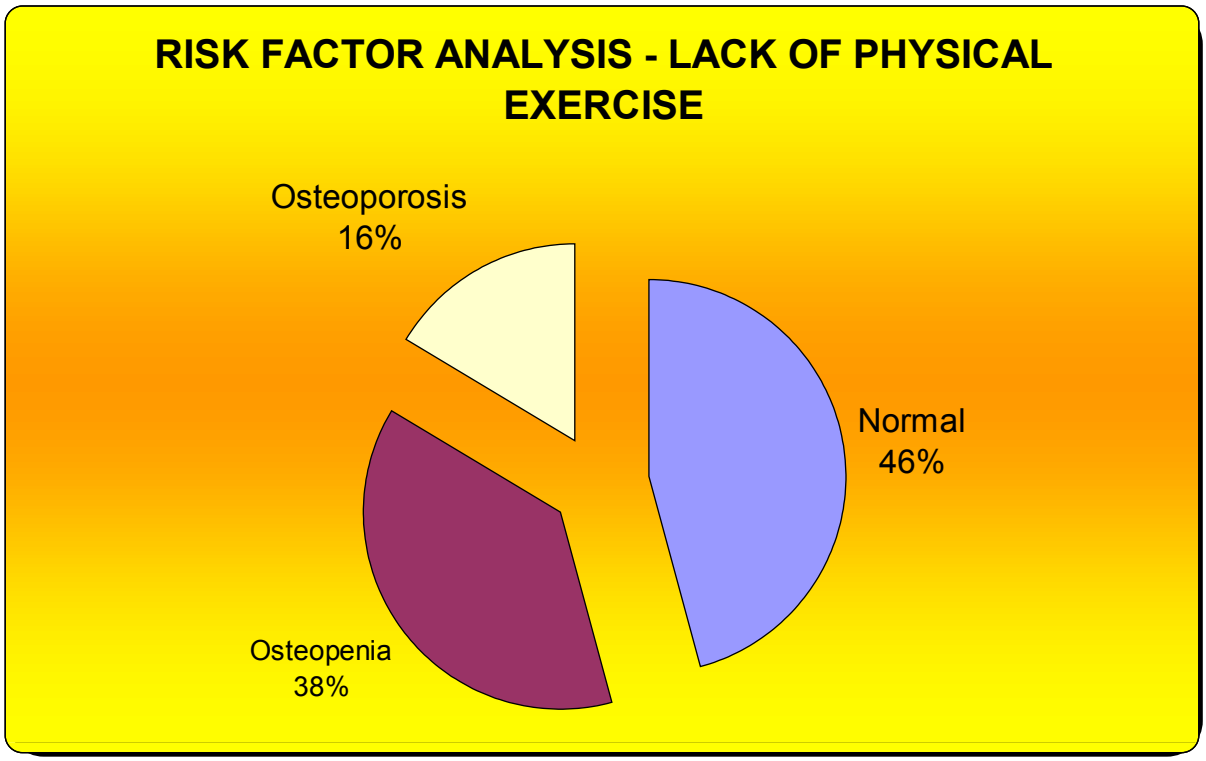

RISK FACTOR ANALYSIS - LACK OF PHYSICAL EXERCISE
Osteoporosis 16%
Normal 46%
Osteopenia 38%

Table 11

HIGH CAFFEINE INTAKE

High Caffeine intake	Normal	Osteopenia	Osteoporosis	Total
NO	77	47	6	130
YES	39	23	18	80
Total	116	70	24	210

38% of the study group has a high caffeine intake of whom 23% had osteoporosis compared to 5% osteoporosis in a group who did not have high caffeine intake

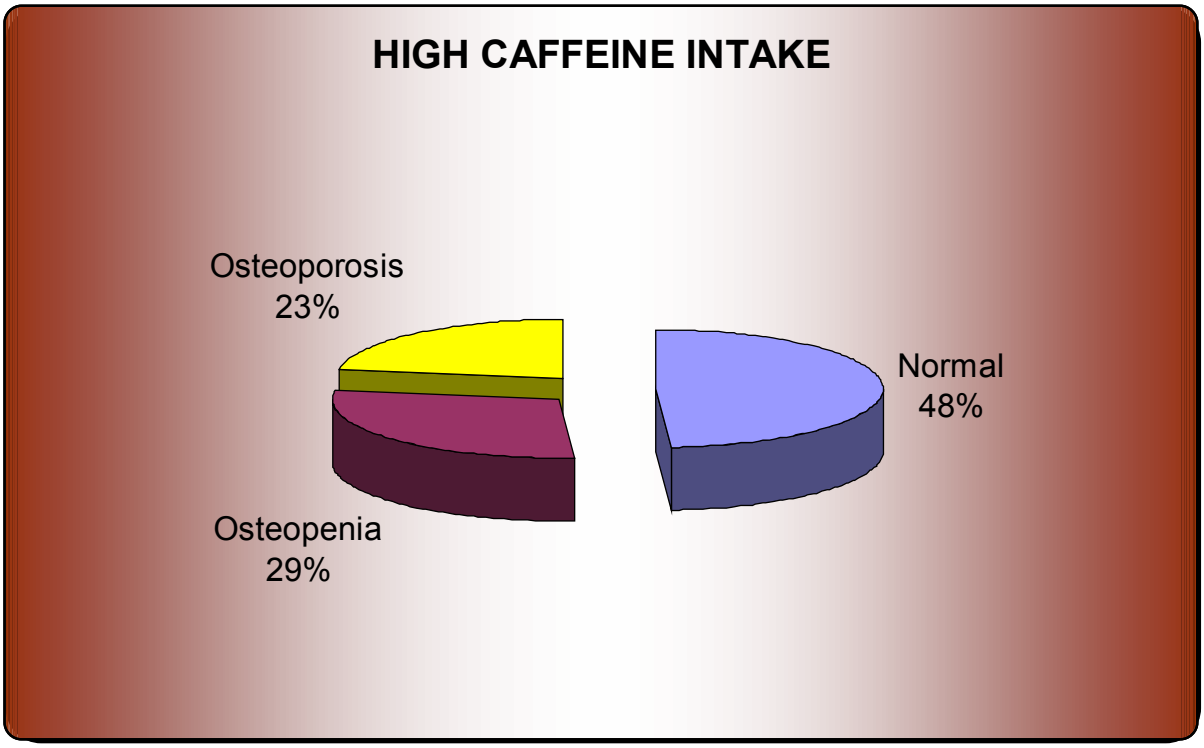

HIGH CAFFEINE INTAKE
Osteoporosis
23%
Osteopenia
29%
Normal
48%

Table 12

LOW CALCIUM INTAKE

Low Calcium	Normal	Osteopenia	Osteoporosis	Total
NO	90	45	11	146
YES	26	25	13	64
Total	116	70	24	210

30% of the study population had a low calcium intake of whom 39% had osteopenia and 20% had osteoporosis

70% of the study population had a normal calcium intake of whom 62% had a normal bone density

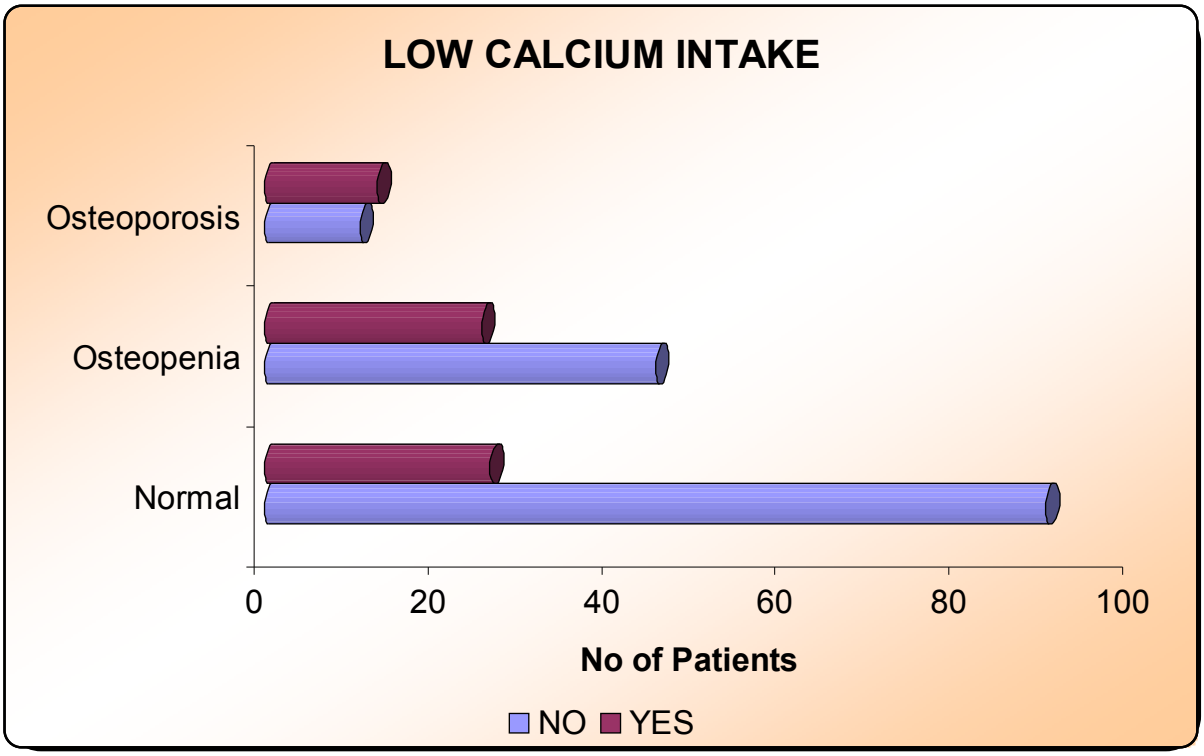

LOW CALCIUM INTAKE
Osteoporosis
Osteopenia
Normal
0
20
40
60
80
100
No of Patients
NO
YES

Table 13

Z SCORE

Age	Group 1	Group 2	Total
41-45	60	4	64
46-50	26	16	42
51-55	16	20	36
56-60	17	11	28
>60	40	0	40
Total	159	51	210

Of the total study population, 76% had a normal bone density when compared to the mean BMD for persons of the same age and 24 % had a low bone density when compared to the mean BMD for the persons of the same age

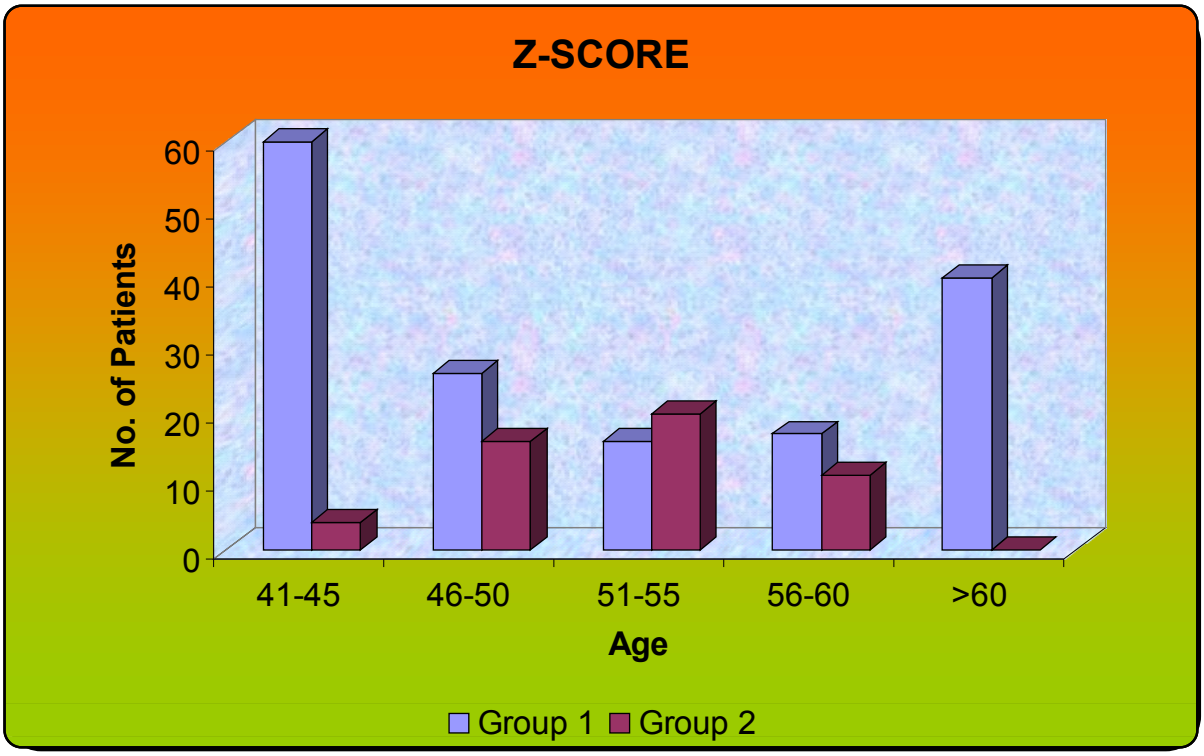
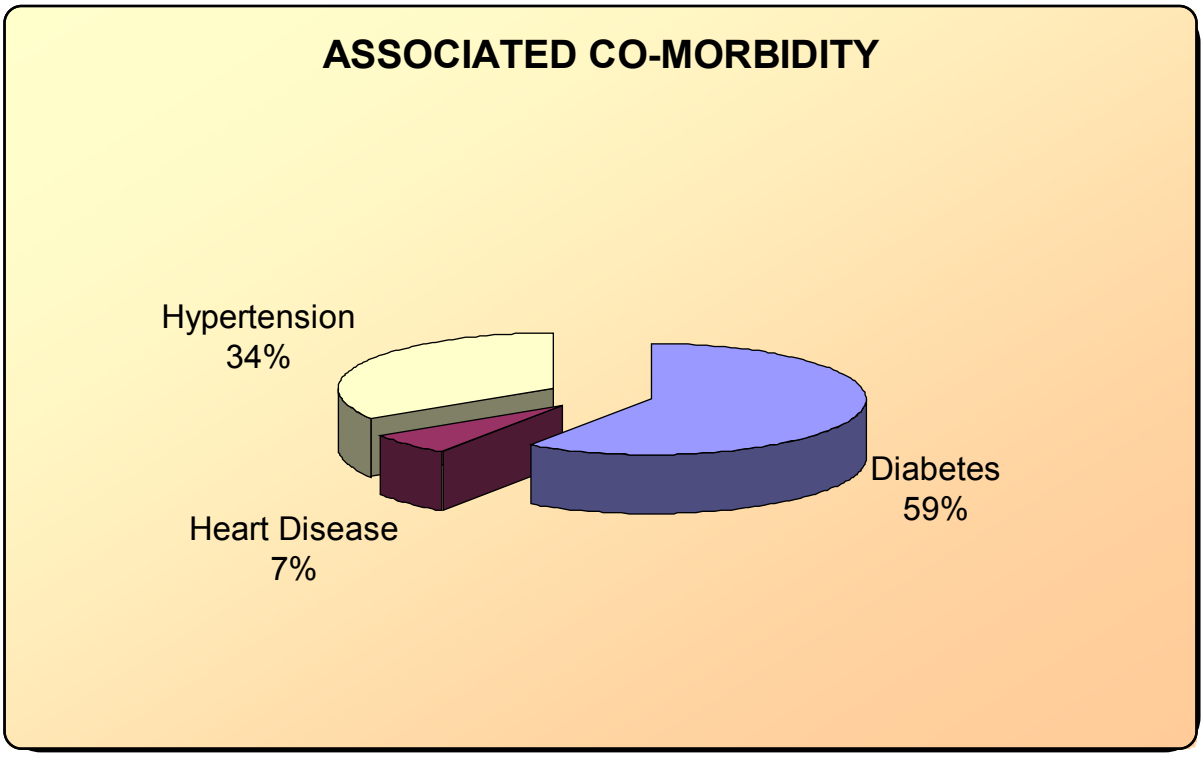

Z-SCORE
No. of Patients
60
50
40
30
20
10
0
41-45
46-50
51-55
56-60
>60
Age
Group 1
Group 2

Table 14

ASSOCIATED CO-MORBIDITY

Diseases	Group 1	Group 2	Total
Diabetes	27	8	35
Heart Disease	0	4	4
Hypertension	20	0	20
Total	47	12	59

In the study population, the incidence of diabetes melitus in the study population was 59% that of systemic hypertension was 34% and ischaemic heart disease was 7%.


ASSOCIATED CO-MORBIDITY
Hypertension
34%
Diabetes
59%
Heart Disease
7%

DISCUSSION

The reference study was conducted at department of obstetrics and gynecology, Ruparel Medical Centre, Worli, Mumbai. 206 perimenopausal and menopausal women had bone density measurement using calcaneal ultrasound after obtaining detailed written consent.

The present study was conducted at Kilpauk Medical College, Chennai. Bone density was measured using Achilles Lunar Calcaneal Ultrasound

AGE: In the reference study, perimenopausal women and menopausal women of age 45 and above were included. The average age of perimenopausal women age was 45 years and that of menopausal women was of 58.5 years.

In the present study, average age of perimenopausal women was 47.7 years and the average age of menopausal women was 57 years. In the present study 34.4% had undergone surgical menopause and in the reference study 11.42% had surgical menopause.

12% in the reference study were nulliparous and in the present study 9.5% were nulliparous.

In the reference study, age presented a negative association with BMD with the P value of 0.064 and in the present study, age had a negative association with BMD with a P value of 0.00001 which is statistically significant

A similar negative association of age with BMD was observed in a study by the Slenenda et al in1990, Elliot et al in1993 and Ballard et al in1998

BODY MASS INDEX: The mean BMI in the reference study was 23.5 and in the mean BMI in the present study is 27.8.

A lower BMI (< 25) was associated with T score of less than -1 with a P value of 0.0011 in the reference study and in the present study a BMI of < 25 was associated with the T Score of less than -1 with a P value of 0.006021 which was statistically significant.

A positive co-relation between low BMI and decreased bone density was observed in the study by Van Hemert et al in 1990, Wolinnsky and Fitzerald in 1994, Johnell et al in 1995.

PHYSICAL EXERCISE: Lack of physical exercise was associated with a lower bone density with a P value of 0.0033 in the reference study.

In the present study lack of physical exercise was associated with a lower bone density with a P value of 0.00003.

In the study by Elliot in the year 1993, Goemaere in 1999, Johnell in 1995 a similar statistically significant association between lack of physical exercise and low bone density was observed.

HIGH CAFFEINE INTAKE: High Caffeine intake was associated with lower bone density with a P value of 0.006 in the reference study and in the present study high caffeine intake was associated with low bone density with the P value of 0.0003.

Higher caffeine intake was associated with lower bone density in studies by Slemenda et al in 1990, Goemaere et al in 1999, Johnell et al in 1995.

LOW CALCIUM INTAKE: In the study population with a calcium intake of less than 800 mg per day, a higher incidence of low bone density was noted in the reference study with a P value of 0.0086. A similar low bone density in population with low calcium intake was observed in studies by Goemaere et al in 1999 and selemenda et al.

In the present study a low calcium intake was associated with lower bone density with a P value of 0.0044

FAMILY HISTORY OF FRACTURE: Family history of fracture was not included in the questionnaire in the reference study.

In the present study, family history of fracture was associated with lower bone density with a P value of 0.00001. A similar association was noted in the studies by Elliot in 1993, Lydick in 1998, Goemaere in 1999 and Kleerekoper in 1989.

ASSOCIATED CO-MORBIDITY: In the reference study, 11% had diabetes, 17% had systemic hypertension and 3% had ischaemic heart disease.

In the present study 59% had diabetes melitus, 34% had systemic hypertension and 7% ischaemic heart diesease.

INCIDENCE OF OSTEOPENIA AND OSTEOPOROSIS IN PERIMENOPAUSAL WOMEN

In the reference study, 30% of the perimenopausal women had osteopenia (T Score < -1 to -2.5) and 5% had osteoporosis.

In the present study, 21% had osteopenia and 8% had osteoporosis.

INCIDENCE OF OSTEOPENIA AND OSTEOPOROSIS IN MENOPAUSAL WOMEN

In the reference study, 38.4% of the menopausal women had osteopenia (T Score < -1 to -2.5) and 48% had osteoporosis.

In the present study, 44% had osteopenia and 14% had osteoporosis.

Z SCORE: The Z score which compares one person's BMD in standard deviations with the mean BMD for persons of the same age and gender rather than with a young adult normal group. The z score of greater than -1 was noted in 76 % of the study population and 24% had a Z score of $\leq$ -1.

This study shows nearly two thirds of the study population had normal bone density when compared to the population of same age and gender.

Z score was not studied in the reference study.

SUMMARY

- 98 perimenopausal women and 112 post menopausal women from age group 40 years and above were selected according to the inclusion and exclusion criteria.
- The mean age of the study group was 52.72 years
- 11.42 % of the study population had undergone surgical menopause
- The mean age of the women who had undergone surgical menopause was 48.83 years and 59.76 years was the mean age of the study group who had experienced natural menopause.
- 81% of the population were from urban area and 53% of the study population had no formal education
- 29% of the study group had a BMI less than 25
- Bone density was measured in the right heel using Achilles Lunar Calcaneal Ultrasound
- The results were interpreted using T-Score and Z-Score criteria for osteopenia and osteoporosis
- A body mass index less than 25, family history of fracture, lack of physical exercise, high caffeine intake, low calcium intake were associated with osteoporosis and the association was found to be statistically significant for each of the above risk factors
- In the perimenopausal women, 21% had osteopenia and 8% had osteoporosis.

- In the menopausal women, 44% had osteopenia and 14% had osteoporosis
- In the women who had undergone surgical menopause, 54% had osteopenia and 21% had osteoporosis.
- 76% of the study group had a normal bone density when compared to mean bone density for persons of the same age and 24% had low bone density.

CONCLUSION

By its nature osteoporosis progresses silently for years without symptoms and is therefore a “silent bone thinning disease” without symptoms. The bone is a mineral bank whose assets must be built up, maintained and protected. The development of lifelong habits of nutrition and weight bearing exercise, avoidance of risk factors that promote the development of osteoporosis and timely management to decrease the withdrawal of bone from the bank are necessary to protect these vital assets from the silent thief osteoporosis.

Bone densitometry has well established usefulness in assessing osteoporosis and fracture risk. Although DEXA (Dual Energy X-Ray Absorptiometry) is the Gold Standard test in the diagonosis of osteoporosis, DEXA has the following disadvantages.

- The equipment is costly and is not portable
- The procedure involves radiation exposure
- It is available only in specialist institution
- It requires time and operator skill

The cost of DEXA precludes its use for screening purposes, especially in developing countries like India where maternal and child health programs receive major chunks in funds from health budget and financial support to programs for geriatric health problems may be negligible.

This is a small clinical trial to study the bone mass of perimenopausal and menopausal women and to diagnose the level of osteoporosis in the community. Calcaneal ultrasound is newer evolving promising tool to assess bone density as it is **precise, noninvasive, quick and cost effective.**

Advantages of QUS

- Equipment cost is substantially low.
- Equipment is generally portable
- There is no radiation exposure
- The device requires much less space.
- The time required for testing is only few minutes
- Does not need operator skill
- QUS is relatively cheap
- The technique is easy as the peripheral skeleton is studied
- QUS has high sensitivity

- QUS expresses qualitative features of bone

Every postmenopausal women and all perimenopausal women with increased risk factor should therefore undergo bone density testing so that they can be saved from the crippling disease. In developing country like India where the burden of osteoporosis in immense and is predicted to increase in the near future, QUS can be used as a cost-effective screening tool for osteoporosis. Almost all patients with BMD in the osteoporotic range on densitometry and many of those with value in osteopenic range should be considered for HRT based on individual risk factor calcium and vitamin D supplementation

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PROFORMA

Name :

Age :

Socio-Economic Class :

Occupation :

Educational Status : No Formal Education / Primary / Secondary

Place of Residence : Urban / Rural

Height :

Weight :

Body Mass Index :

Menstrual History :

Menstruating		**Post-Menopausal**	
Regular	Irregular	Natural	Surgical (Hysterectomy with both ovaries removed)

History of : Diabetes/Hypertension/Ischaemic Heart Disease:

Family H/O of Fracture :

Dietary Habits : Total Calories

Total Calcium Intake

Total Caffeine Intake

H/O Calcium Supplementation:

Dose and Duration

Physical Activity **:** Nil

Active Physical Exercise: Walking

Cycling

Swimming

H/O Hormone Replacement Therapy

MASTER CHART

Name	Age	Occupation	Weight (kg)	Height (cm)	BMI
Usha	41	Tailor	67	153	28.62
Usha	41	Optometrist	67	153	28.62
Vijayalakshmi	41	housewife	67	153	28.62
Lathadevi	41	housemaid	67	153	28.62
Selvi	41	Housewife	60	154	25.3
Selvi	41	Housewife	60	154	25.3
Amirthammal	41	Housewife	60	154	25.3
Kuppamal	41	Housewife	60	154	25.3
Parvathi	41	Housewife	73	150	32.44
Paravathammal	41	Housewife	73	150	32.44
Rajini	41	Housewife	73	150	32.44
Muthamizh	41	Housewife	73	150	32.44
Anitha B	42	Housewife	55	154	23.19
Ulagammal	42	Housewife	55	154	23.19
Thenmozhi	42	Housewife	55	154	23.19
Manikkavalli	42	Housewife	55	154	23.19
Ananthi	42	Housewife	68	152	29.43
Mariyammal	42	Housewife	68	152	29.43
Roja	42	Housewife	68	152	29.43
Irudayam	42	Housewife	68	152	29.43
Ezhilarasi	43	Housewife	60	153	25.63
Ezhilarasi	43	Housewife	60	153	25.63
Suryakala	43	Housewife	60	153	25.63
Bagyam	43	Housewife	60	153	25.63
Haripriya	43	Housewife	74	144	35.69
Kalai	43	Housewife	74	144	35.69
Muthamizhselvi	43	Housewife	74	144	35.69
Malathi Priya	43	Housewife	74	144	35.69

Menstrual History	No. Of Children	Medical Disorders		
		Diabetes	Heart Disease	Hypertension
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	1	NO	NO	NO
Regular	1	NO	NO	NO
Regular	1	NO	NO	NO
Regular	1	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Hysterectomy Done	2	NO	NO	NO
Hysterectomy Done	2	NO	NO	NO
Hysterectomy Done	2	NO	NO	NO
Hysterectomy Done	2	NO	NO	NO
Regular	1	NO	NO	NO
Regular	1	NO	NO	NO
Regular	1	NO	NO	NO
Regular	1	NO	NO	NO

Risk Factors						
Sedentary Lifestyle	**Nulliparity**	**High Caffeine Intake**	**Low Calcium Intake**	**Steroids**	**Family H/O Fracture**	**Post-Menopausal Status**
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
YES	NIL	YES	NO	NO	NO	NO
YES	NIL	YES	NO	NO	NO	NO
YES	NIL	YES	NO	NO	NO	NO
YES	NIL	YES	NO	NO	NO	NO
NIL	NIL	NO	YES	NO	NO	NO
NIL	NIL	NO	YES	NO	NO	NO
NIL	NIL	NO	YES	NO	NO	NO
NIL	NIL	NO	YES	NO	NO	NO
YES	NIL	YES	NO	NO	NO	YES
YES	NIL	YES	NO	NO	NO	YES
YES	NIL	YES	NO	NO	NO	YES
YES	NIL	YES	NO	NO	NO	YES
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO

HRT	T-Score	Z-Score	Stiffness Index
NO	-1.2	-1.2	81
NO	-1.2	-1.2	81
NO	-1.2	-1.2	81
NO	-1.2	-1.2	81
NO	0.2	0.3	103
NO	0.2	0.3	103
NO	0.2	0.3	103
NO	0.2	0.3	103
NO	0.7	0.8	111
NO	0.7	0.8	111
NO	0.7	0.8	111
NO	0.7	0.8	111
NO	-1	-0.9	85
NO	-1	-0.9	85
NO	-1	-0.9	85
NO	-1	-0.9	85
NO	-0.2	0	97
NO	-0.2	0	97
NO	-0.2	0	97
NO	-0.2	0	97
NO	-0.9	-0.8	85
NO	-0.9	-0.8	85
NO	-0.9	-0.8	85
NO	-0.9	-0.8	85
NO	0.3	0.3	104
NO	0.3	0.3	104
NO	0.3	0.3	104
NO	0.3	0.3	104

Name	Age	Occupation	Weight (kg)	Height (cm)	BMI
Muniammal	43	Housewife	38	140	19.39
Muniammal	43	Housewife	38	140	19.39
Logammal	43	Housewife	38	140	19.39
Senthamizselvi	43	Housewife	38	140	19.39
Selvi	43	Housewife	80	164	29.74
Selvi	43	Housewife	80	164	29.74
Sulokshana	43	Housewife	80	164	29.74
Latha	43	Housewife	80	164	29.74
Uma	43	Labourer	64	150	28.44
Uma Rani	43	Labourer	64	150	28.44
Mumthaz Begam	43	Labourer	64	150	28.44
Mangayarkarasi	43	Labourer	64	150	28.44
Visalakshi	44	Housewife	66	157	26.78
Visalakshi	44	Housewife	66	157	26.78
Manikkadevi	44	Housewife	66	157	26.78
Ragini	44	Housewife	66	157	26.78
Shantha	44	Housewife	72	164	26.77
Mohana	44	Housewife	72	164	26.77
Kanimozhi	44	Housewife	72	164	26.77
Kaveri	44	Housewife	72	164	26.77
Vasanthi	45	Warden	49	160	19.14
Vasantha	45	Housewife	49	160	19.14
Thamizarasi	45	housemaid	49	160	19.14
Poongodi	45	accountant	49	160	19.14
Ramya	45	Housewife	69	155	28.72
Easwari	45	Housewife	69	155	28.72
Nargeez Banu	45	Housewife	69	155	28.72
Sarasu	45	Housewife	69	155	28.72

Menstrual History	No. Of Children	Medical Disorders		
		Diabetes	Heart Disease	Hypertension
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Hysterectomy Done	3	NO	NO	NO
Hysterectomy Done	3	NO	NO	NO
Hysterectomy Done	3	NO	NO	NO
Hysterectomy Done	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	4	NO	NO	NO
Regular	4	NO	NO	NO
Regular	4	NO	NO	NO
Regular	4	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO

Risk Factors						
Sedentary Lifestyle	**Nulliparity**	**High Caffeine Intake**	**Low Calcium Intake**	**Steroids**	**Family H/O Fracture**	**Post-Menopausal Status**
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
YES	NIL	YES	YES	NO	NO	NO
YES	NIL	YES	YES	NO	NO	NO
YES	NIL	YES	YES	NO	NO	NO
YES	NIL	YES	YES	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO

HRT	T-Score	Z-Score	Stiffness Index
NO	0.4	1	105
NO	0.4	1	105
NO	0.4	1	105
NO	0.4	1	105
NO	0.6	0.6	101
NO	0.6	0.6	101
NO	0.6	0.6	101
NO	0.6	0.6	101
NO	0.7	0.6	89
NO	0.7	0.6	89
NO	0.7	0.6	89
NO	0.7	0.6	89
NO	-0.6	-0.5	91
NO	-0.6	-0.5	91
NO	-0.6	-0.5	91
NO	-0.6	-0.5	91
NO	0.8	0.9	113
NO	0.8	0.9	113
NO	0.8	0.9	113
NO	0.8	0.9	113
NO	-0.5	-0.5	93
NO	-0.5	-0.5	93
NO	-0.5	-0.5	93
NO	-0.5	-0.5	93
NO	-0.3	-0.1	95
NO	-0.3	-0.1	95
NO	-0.3	-0.1	95
NO	-0.3	-0.1	95

Name	Age	Occupation	Weight (kg)	Height (cm)	BMI
Rajalakshmi	45	Housewife	85	180	26.23
Rajalakshmi	45	Housewife	85	180	26.23
Lakshmi	45	Housewife	85	180	26.23
Dhanam	45	Housewife	85	180	26.23
Parimala	45	Housewife	59	149	26.58
Yogeswari	45	Housewife	59	149	26.58
Ezhilarasi	45	Housewife	59	149	26.58
Priya	45	Housewife	59	149	26.58
Shanthi	46	Labourer	46	140	23.47
Aarthy Gopal	46	Labourer	46	140	23.47
Gayathri	46	Labourer	46	140	23.47
Abirami	46	Labourer	46	140	23.47
Maliga	46	Housewife	63	146	29.56
Irudaya Mary	46	Housewife	63	146	29.56
Ragini	46	Housewife	60	153	25.63
Jevitha Rani	46	Housewife	60	153	25.63
Sundari	46	Housewife	60	153	25.63
Balanagammal	46	Housewife	60	153	25.63
Mumtaz	47	Accountant	75	169	26.26
Mumtaz	47	Accounts Executive	75	169	26.26
Shailabanu	47	housewife	75	169	26.26
Geeta	47	office assistant	75	169	26.26
Mala	47	Housewife	69	150	30.67
Malarvizhi	47	Housewife	69	150	30.67
Punitha	47	Housewife	69	150	30.67
Punithavalli	47	Housewife	69	150	30.67
Bakya	47	Housemaid	75	150	33.33
Emily Margarat	47	housewife	75	150	33.33

Menstrual History	No. Of Children	Medical Disorders		
		Diabetes	Heart Disease	Hypertension
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	1	NO	NO	NO
Regular	1	NO	NO	NO
Regular	1	NO	NO	NO
Regular	1	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	1	NO	NO	NO
Regular	1	NO	NO	NO
Regular	1	NO	NO	NO
Regular	1	NO	NO	NO
Hysterectomy Done	2	NO	NO	YES
Hysterectomy Done	2	NO	NO	YES
Hysterectomy Done	2	NO	NO	YES
Hysterectomy Done	2	NO	NO	YES
Menopause	nil	YES	NO	YES
Menopause	nil	YES	NO	YES

Risk Factors						
Sedentary Lifestyle	**Nulliparity**	**High Caffeine Intake**	**Low Calcium Intake**	**Steroids**	**Family H/O Fracture**	**Post-Menopausal Status**
NIL	NIL	NO	NO	NO	NO	YES
NIL	NIL	NO	NO	NO	NO	YES
NIL	NIL	NO	NO	NO	NO	YES
NIL	NIL	NO	NO	NO	NO	YES
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	YES	NO	NO
YES	NIL	NO	NO	YES	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	YES	NO	NO	NO
YES	NIL	NO	YES	NO	NO	NO
YES	NIL	NO	YES	NO	NO	NO
YES	NIL	NO	YES	NO	NO	NO
YES	NIL	YES	NO	NO	NO	YES
YES	NIL	YES	NO	NO	NO	YES
YES	NIL	YES	NO	NO	NO	YES
YES	NIL	YES	NO	NO	NO	YES
NIL	YES	NO	NO	NO	NO	YES
NIL	YES	NO	NO	NO	NO	YES

HRT	T-Score	Z-Score	Stiffness Index
NO	0.7	1	112
NO	0.7	1	112
NO	0.7	1	112
NO	0.7	1	112
NO	2.3	3.2	130
NO	2.3	3.2	130
NO	2.3	3.2	130
NO	2.3	3.2	130
NO	-2.1	-1.9	66
NO	-2.1	-1.9	66
NO	-2.1	-1.9	66
NO	-2.1	-1.9	66
NO	-0.8	-0.5	
NO	-0.8	-0.5	
NO	-0.3	-0.1	95
NO	-0.3	-0.1	95
NO	-0.3	-0.1	95
NO	-0.3	-0.1	95
NO	-1.3	-1.2	79
NO	-1.3	-1.2	79
NO	-1.3	-1.2	79
NO	-1.3	-1.2	79
NO	-1.1	0.7	83
NO	-1.1	0.7	83
NO	-1.1	0.7	83
NO	-1.1	0.7	83
NO	0.1	0.5	102
NO	0.1	0.5	102

Name	Age	Occupation	Weight (kg)	Height (cm)	BMI
Vedavalli	47	clerk	75	150	33.33
Arasi	47	housewife	75	150	33.33
Geeta	48	Housewife	49	143	23.96
Geeta Mary	48	Housewife	49	143	23.96
Nayagi	48	Housewife	49	143	23.96
Malakodi	48	Housewife	49	143	23.96
Parameswari	48	Housewife	65	147	30.08
Parameswari	48	Housewife	65	147	30.08
Kamala Mary	48	Housewife	65	147	30.08
Muthulakshmi	48	Housewife	65	147	30.08
Suguna	49	Housewife	64	160	25
Suguna	49	Housewife	64	160	25
Dhanabagyam	49	Housewife	64	160	25
Nirmala	49	Housewife	64	160	25
Viajakumari	50	Housewife	50	130	29.59
Nagarani	50	Housewife	50	130	29.59
Kokila	50	Housewife	50	130	29.59
Saraswathi	50	Housewife	50	130	29.59
Jyothi	50	Housewife	67	160	26.17
Jyothi	50	Housewife	67	160	26.17
Mangala Arasi	50	Housewife	67	160	26.17
Jagathammal	50	Housewife	67	160	26.17
Indrani S	51	Clerk	65	140	33.16
Gomathi	51	Office Superdintendent	65	140	33.16
Sornam	51	housewife	65	140	33.16
Devipriya	51	clerk	65	140	33.16
Jyothi	51	Housewife	73	154	30.78
Lakshmipriya	51	Housewife	73	154	30.78

Menstrual History	No. Of Children	Medical Disorders		
		Diabetes	Heart Disease	Hypertension
Menopause	nil	YES	NO	YES
Menopause	nil	YES	NO	YES
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Regular	3	NO	NO	NO
Menopause	3	NO	NO	NO
Menopause	3	NO	NO	NO
Menopause	3	NO	NO	NO
Menopause	3	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	n	NO	NO	NO
Menopause	n	NO	NO	NO
Menopause	n	NO	NO	NO
Menopause	n	NO	NO	NO
Irregular	2	NO	NO	NO
Irregular	2	NO	NO	NO
Irregular	2	NO	NO	NO
Irregular	2	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO

Risk Factors						
Sedentary Lifestyle	**Nulliparity**	**High Caffeine Intake**	**Low Calcium Intake**	**Steroids**	**Family H/O Fracture**	**Post-Menopausal Status**
NIL	YES	NO	NO	NO	NO	YES
NIL	YES	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	YES	NO	NO	NO	YES
YES	NIL	YES	NO	NO	NO	YES
YES	NIL	YES	NO	NO	NO	YES
YES	NIL	YES	NO	NO	NO	YES
YES	YES	NO	YES	YES	YES	YES
YES	YES	NO	YES	YES	YES	YES
YES	YES	NO	YES	YES	YES	YES
YES	YES	NO	YES	YES	YES	YES
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	YES	NO	NO	NO
NIL	NIL	NO	YES	NO	NO	NO
NIL	NIL	NO	YES	NO	NO	NO
NIL	NIL	NO	YES	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO

HRT	T-Score	Z-Score	Stiffness Index
NO	0.1	0.5	102
NO	0.1	0.5	102
NO	-0.5	-0.1	92
NO	-0.5	-0.1	92
NO	-0.5	-0.1	92
NO	-0.5	-0.1	92
NO	-0.2	0.1	96
NO	-0.2	0.1	96
NO	-0.2	0.1	96
NO	-0.2	0.1	96
NO	-1	-0.6	84
NO	-1	-0.6	84
NO	-1	-0.6	84
NO	-1	-0.6	84
NO	-1.8	-1.3	71
NO	-1.8	-1.3	71
NO	-1.8	-1.3	71
NO	-1.8	-1.3	71
NO	-1.7	-1.7	75
NO	-1.7	-1.7	75
NO	-1.7	-1.7	75
NO	-1.7	-1.7	75
NO	-1.9	-1.4	69
NO	-1.9	-1.4	69
NO	-1.9	-1.4	69
NO	-1.9	-1.4	69
NO	-1.4	-1.4	78
NO	-1.4	-1.4	78

Name	Age	Occupation	Weight (kg)	Height (cm)	BMI
Joythishwari	51	Housewife	73	154	30.78
Rajameenakshi	51	Housewife	73	154	30.78
Usha	51	Housewife	60	148	27.39
Sudha Rani	51	Housewife	60	148	27.39
Kavitha	51	Housewife	60	148	27.39
Naramada	51	Housewife	60	148	27.39
Majula	52	Housewife	55	154	23.19
Malarvizhi	52	Housewife	55	154	23.19
Anantavalli	52	Housewife	55	154	23.19
Senthamarai	52	Housewife	55	154	23.19
Indrani P	54	Housewife	54	150	24
Sarathambal	54	Housewife	54	150	24
Padma	54	Housewife	54	150	24
Rasathi	54	Housewife	54	150	24
Rani	54	Housewife	63	148	28.76
Kausalya	54	Housewife	80	150	35.56
Kausalya	54	Housewife	80	150	35.56
Nagammal	54	Housewife	63	148	28.76
Theivanayagi	54	Housewife	80	150	35.56
Kamala	54	Housewife	80	150	35.56
Anjala	54	Housewife	63	148	28.76
Nagammal	54	Housewife	63	148	28.76
Indrani	55	Housewife	60	160	23.44
Indra	55	Housewife	60	160	23.44
Valli	55	Housewife	60	160	23.44
Ganga	55	Housewife	60	160	23.44
Shantha	55	Housewife	80	150	35.56
Jayalakshmi	55	Housewife	80	150	35.56

Menstrual History	No. Of Children	Medical Disorders		
		Diabetes	Heart Disease	Hypertension
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Hysterectomy Done	2	YES	NO	YES
Hysterectomy Done	2	YES	NO	YES
Hysterectomy Done	2	YES	NO	YES
Hysterectomy Done	2	YES	NO	YES
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Regular	2	NO	NO	NO
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	NO
Hysterectomy Done	2	YES	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Hysterectomy Done	2	YES	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Hysterectomy Done	2	YES	NO	NO
Hysterectomy Done	2	YES	NO	NO
Hysterectomy Done	7	YES	YES	NO
Hysterectomy Done	7	YES	YES	NO
Hysterectomy Done	7	YES	YES	NO
Hysterectomy Done	7	YES	YES	NO
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	NO

Risk Factors						
Sedentary Lifestyle	**Nulliparity**	**High Caffeine Intake**	**Low Calcium Intake**	**Steroids**	**Family H/O Fracture**	**Post-Menopausal Status**
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	YES	NO	NO	YES	YES
YES	NIL	YES	NO	NO	YES	YES
YES	NIL	YES	NO	NO	YES	YES
YES	NIL	YES	NO	NO	YES	YES
NIL	NIL	NO	NO	NO	NO	YES
NIL	NIL	NO	NO	NO	NO	YES
NIL	NIL	NO	NO	NO	NO	YES
NIL	NIL	NO	NO	NO	NO	YES
YES	NIL	YES	YES	NO	YES	YES
YES	NIL	YES	YES	NO	YES	YES
YES	NIL	YES	YES	NO	YES	YES
YES	NIL	YES	YES	NO	YES	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES

HRT	T-Score	Z-Score	Stiffness Index
NO	-1.4	-1.4	78
NO	-1.4	-1.4	78
YES	-1.3	-0.7	80
YES	-1.3	-0.7	80
YES	-1.3	-0.7	80
YES	-1.3	-0.7	80
NO	-1.7	-1.7	72
NO	-1.7	-1.7	72
NO	-1.7	-1.7	72
NO	-1.7	-1.7	72
NO	-2.7	-1.9	82
NO	-2.7	-1.9	82
NO	-2.7	-1.9	82
NO	-2.7	-1.9	82
NO	-1.5	-0.7	75
NO	-1.5	0.6	76
NO	-1.5	0.6	76
NO	-1.5	-0.7	75
NO	-1.5	0.6	76
NO	-1.5	0.6	76
NO	-1.5	-0.7	75
NO	-1.5	-0.7	75
NO	-2.6	-1.6	59
NO	-2.6	-1.6	59
NO	-2.6	-1.6	59
NO	-2.6	-1.6	59
NO	1	1.9	116
NO	1	1.9	116

Name	Age	Occupation	Weight (kg)	Height (cm)	BMI
Banu	55	Housewife	80	150	35.56
Parichatham	55	Housewife	80	150	35.56
Kalawathy	58	Housewife	57	148	26.02
Priyadevi	58	Housewife	57	148	26.02
Theivanai	58	Housewife	57	148	26.02
Kasthuri	58	Housewife	57	148	26.02
Saraswathy	59	Housewife	94	148	42.91
Kumudha	59	Housewife	94	148	42.91
Sarasu	59	Housewife	94	148	42.91
Aatchi	59	Housewife	94	148	42.91
Chellamal	60	Housewife	74	140	37.76
Rajam	60	Housewife	55	150	24.44
Stella Mary	60	Housewife	74	140	37.76
Rajalakshmi	60	Housewife	55	150	24.44
Vidya	60	Housewife	55	150	24.44
Manimozhi	60	Housewife	74	140	37.76
Mangalam	60	Housewife	74	140	37.76
Nagalakshmi	60	Housewife	55	150	24.44
Panjalai	60	Housewife	38	145	18.07
Devipriya	60	Housewife	38	145	18.07
Lurdhu Mary	60	Housewife	38	145	18.07
Gajalakshmi	60	Housewife	38	145	18.07
Aarthy	60	Housewife	55	150	24.44
Vishalakshi	60	Housewife	55	150	24.44
Urvasi	60	Housewife	55	150	24.44
Loganayagi	60	Housewife	55	150	24.44
Parvathammal	60	Housewife	59	156	24.24
Suganthammal	60	Housewife	59	156	24.24

Menstrual History	No. Of Children	Medical Disorders		
		Diabetes	Heart Disease	Hypertension
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Irregular	2	NO	NO	NO
Irregular	2	NO	NO	NO
Irregular	2	NO	NO	NO
Irregular	2	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	3	YES	NO	NO
Menopause	2	NO	NO	NO
Menopause	3	YES	NO	NO
Menopause	3	YES	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	3	YES	NO	NO
Menopause	nil	NO	NO	NO
Menopause	nil	NO	NO	NO
Menopause	nil	NO	NO	NO
Menopause	nil	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	2	NO	NO	NO
Menopause	nil	YES	NO	NO
Menopause	nil	YES	NO	NO

Risk Factors						
Sedentary Lifestyle	**Nulliparity**	**High Caffeine Intake**	**Low Calcium Intake**	**Steroids**	**Family H/O Fracture**	**Post-Menopausal Status**
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	YES	YES	NO	YES	NO
YES	NIL	YES	YES	NO	YES	NO
YES	NIL	YES	YES	NO	YES	NO
YES	NIL	YES	YES	NO	YES	NO
YES	NIL	YES	YES	YES	YES	NO
YES	NIL	YES	NO	NO	YES	YES
YES	NIL	YES	YES	YES	YES	NO
YES	NIL	YES	NO	NO	YES	YES
YES	NIL	YES	NO	NO	YES	YES
YES	NIL	YES	YES	YES	YES	NO
YES	NIL	YES	YES	YES	YES	NO
YES	NIL	YES	NO	NO	YES	YES
YES	YES	NO	NO	NO	YES	YES
YES	YES	NO	NO	NO	YES	YES
YES	YES	NO	NO	NO	YES	YES
YES	YES	NO	NO	NO	YES	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	YES	YES	YES	NO	YES	YES
YES	YES	YES	YES	NO	YES	YES

HRT	T-Score	Z-Score	Stiffness Index
NO	1	1.9	116
NO	1	1.9	116
NO	0.1	0.6	101
NO	0.1	0.6	101
NO	0.1	0.6	101
NO	0.1	0.6	101
NO	-3.7	2	40
NO	-3.7	-3.7	40
NO	-3.7	-3.7	40
NO	-3.7	-3.7	40
NO	-2.5	-1.1	61
YES	-2.5	-1.1	69
NO	-2.5	-1.1	61
YES	-2.5	-1.1	69
YES	-2.5	-1.1	69
NO	-2.5	-1.1	61
NO	-2.5	-1.1	61
YES	-2.5	-1.1	69
NO	-2.1	-0.6	73
NO	-2.1	-0.6	73
NO	-2.1	-0.6	73
NO	-2.1	-0.6	73
NO	-1	-0.1	87
NO	-1	-0.1	87
NO	-1	-0.1	87
NO	-1	-0.1	87
NO	-0.3	1.1	96
NO	-0.3	1.1	96

Name	Age	Occupation	Weight (kg)	Height (cm)	BMI
Balasundari	60	Housewife	59	156	24.24
Thamiz	60	Housewife	59	156	24.24
Shakunthala	62	Housewife	67	167	24.02
Sublakshmi	62	Housewife	67	167	24.02
Ranjinidevi	62	Housewife	67	167	24.02
Vimala	62	Housewife	67	167	24.02
Narmada	63	Housewife	72	152	31.16
Narmada	63	Housewife	72	152	31.16
Selvarani	63	Housewife	72	152	31.16
Gajalakshmi	63	Housewife	72	152	31.16
Manimegalai	63	Housewife	56	154	23.61
Manimegalai	63	Housewife	56	154	23.61
Ranjini	63	Housewife	56	154	23.61
Thayammal	63	Housewife	56	154	23.61
Suryakantha	65	Housewife	65	147	30.08
Amudha	65	Housewife	65	147	30.08
Rajam	65	Housewife	65	147	30.08
Sumathi	65	Housewife	65	147	30.08
Ramya	66	Housewife	61	154	25.72
Vijita Bai	66	houseMaid	61	154	25.72
Ellamal	66	Labourer	61	154	25.72
Kumudha	66	FlowerVendor	61	154	25.72
Andal	69	Housewife	60	147	27.77
Parimala	69	Housewife	60	147	27.77
Priya Mani	69	Housewife	60	147	27.77
Thangam	69	Housewife	60	147	27.77
Rajeswari	72	Housewife	57	150	25.33
Raja Rajeswari	72	Housewife	57	150	25.33

Menstrual History	No. Of Children	Medical Disorders		
		Diabetes	Heart Disease	Hypertension
Menopause	nil	YES	NO	NO
Menopause	nil	YES	NO	NO
Menopause	nil	NO	NO	NO
Menopause	nil	NO	NO	NO
Menopause	nil	NO	NO	NO
Menopause	nil	NO	NO	NO
Menopause	3	NO	NO	YES
Menopause	3	NO	NO	YES
Menopause	3	NO	NO	YES
Menopause	3	NO	NO	YES
Menopause	4	YES	NO	NO
Menopause	4	YES	NO	NO
Menopause	4	YES	NO	NO
Menopause	4	YES	NO	NO
Menopause	3	YES	NO	NO
Menopause	3	YES	NO	NO
Menopause	3	YES	NO	NO
Menopause	3	YES	NO	NO
Menopause	3	NO	NO	NO
Menopause	3	NO	NO	NO
Menopause	3	NO	NO	NO
Menopause	3	NO	NO	NO
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	YES
Menopause	4	NO	NO	YES

Risk Factors						
Sedentary Lifestyle	**Nulliparity**	**High Caffeine Intake**	**Low Calcium Intake**	**Steroids**	**Family H/O Fracture**	**Post-Menopausal Status**
YES	YES	YES	YES	NO	YES	YES
YES	YES	YES	YES	NO	YES	YES
YES	YES	YES	YES	NO	NO	YES
YES	YES	YES	YES	NO	NO	YES
YES	YES	YES	YES	NO	NO	YES
YES	YES	YES	YES	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	YES	NO	NO	NO	NO
YES	NIL	YES	NO	NO	NO	NO
YES	NIL	YES	NO	NO	NO	NO
YES	NIL	YES	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
YES	NIL	NO	NO	NO	NO	NO
NIL	NIL	NO	NO	NO	NO	YES
NIL	NIL	NO	NO	NO	NO	YES
NIL	NIL	NO	NO	NO	NO	YES
NIL	NIL	NO	NO	NO	NO	YES
YES	NIL	YES	NO	NO	NO	YES
YES	NIL	YES	NO	NO	NO	YES
YES	NIL	YES	NO	NO	NO	YES
YES	NIL	YES	NO	NO	NO	YES
YES	NIL	YES	YES	NO	YES	YES
YES	NIL	YES	YES	NO	YES	YES

HRT	T-Score	Z-Score	Stiffness Index
NO	-0.3	1.1	96
NO	-0.3	1.1	96
NO	-0.7	0.8	89
NO	-0.7	0.8	89
NO	-0.7	0.8	89
NO	-0.7	0.8	89
NO	-2	0	92
NO	-2	0	92
NO	-2	0	92
NO	-2	0	92
NO	-0.6	0.9	90
NO	-0.6	0.9	90
NO	-0.6	0.9	90
NO	-0.6	0.9	90
NO	-1.1	0.5	82
NO	-1.1	0.5	82
NO	-1.1	0.5	82
NO	-1.1	0.5	82
NO	-0.4	0.9	93
NO	-0.4	0.9	93
NO	-0.4	0.9	93
NO	-0.4	0.9	93
NO	-0.3	1.5	96
NO	-0.3	1.5	96
NO	-0.3	1.5	96
NO	-0.3	1.5	96
NO	1.5	3.3	124
NO	1.5	3.3	124

Name	Age	Occupation	Weight (kg)	Height (cm)	BMI
Valliyammal	72	Housewife	57	150	25.33
Ganga	72	Housewife	57	150	25.33
Gnanmbal	73	Housewife	77	145	36.62
Gnanmbal	73	Housewife	77	145	36.62
Veerammal	73	Housewife	77	145	36.62
Ganthimathi	73	Housewife	77	145	36.62
Ponmozhi	75	Housewife	56	144	27.01
Kayalmozhi	75	Housewife	56	144	27.01
Saradha	75	Housewife	56	144	27.01
Meenakshi	75	Housewife	56	144	27.01
Chandrabai	75	Housewife	63	143	30.81
Thamizselvi	75	Housewife	63	143	30.81
Girija	75	Housewife	63	143	30.81
Dhanam	75	Housewife	63	143	30.81

Menstrual History	No. Of Children	Medical Disorders		
		Diabetes	Heart Disease	Hypertension
Menopause	4	NO	NO	YES
Menopause	4	NO	NO	YES
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	NO
Menopause	4	NO	NO	NO
Menopause	4	YES	NO	NO
Menopause	4	YES	NO	NO
Menopause	4	YES	NO	NO
Menopause	4	YES	NO	NO

Risk Factors						
Sedentary Lifestyle	**Nulliparity**	**High Caffeine Intake**	**Low Calcium Intake**	**Steroids**	**Family H/O Fracture**	**Post-Menopausal Status**
YES	NIL	YES	YES	NO	YES	YES
YES	NIL	YES	YES	NO	YES	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	NO	NO	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES
YES	NIL	YES	YES	NO	NO	YES

HRT	T-Score	Z-Score	Stiffness Index
NO	1.5	3.3	124
NO	1.5	3.3	124
NO	-2.4	-0.5	62
NO	-2.4	-0.5	62
NO	-2.4	-0.5	62
NO	-2.4	-0.5	62
NO	-2.2	-0.3	65
NO	-2.2	-0.3	65
NO	-2.2	-0.3	65
NO	-2.2	-0.3	65
NO	-2.1	-0.2	67
NO	-2.1	-0.2	67
NO	-2.1	-0.2	67
NO	-2.1	-0.2	67